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Master Class at the Louvre

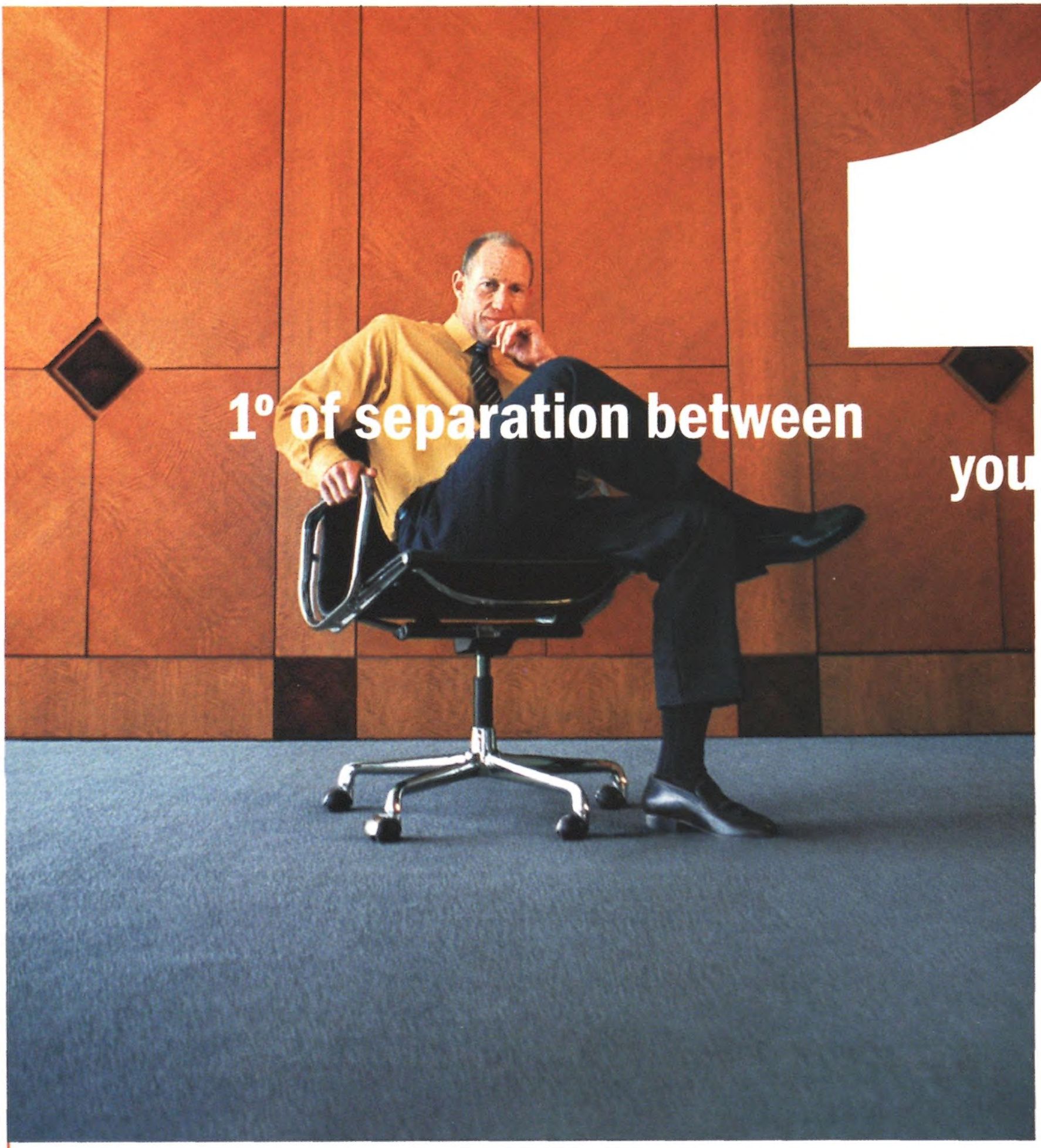
The Cuban Missile Crisis 40 Years Later

Sulfur Caves Disgorge Some Surprising Secrets

Will the Kakapo Go the Way of the Dodo?

The Irrepressible Louis Leakey

Book Excerpt: Battling Superbugs



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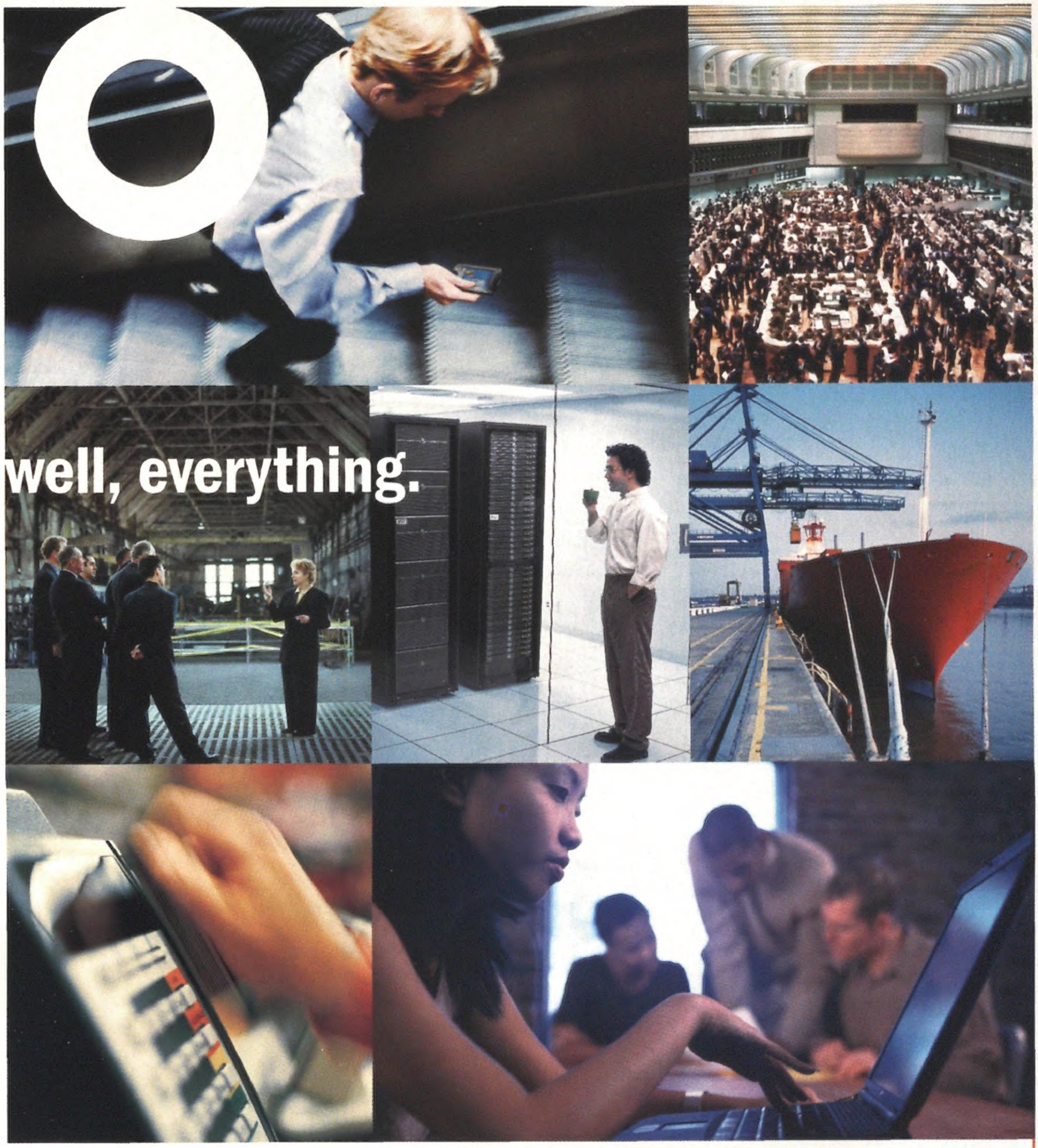

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From top: Biologist Cristina Sandoval considers an adult female walkingstick; the Japanese "Wings of a Phoenix" cigarette brand, c. 1941; *Pool Party*, John Valadez, 1986; photographer George Silk covers the 1972 Winter Olympics in Sapporo, Japan. **COVER: Artist Sorrel Smith copies Delacroix's *The Women of Algiers*. Photograph by Eric Sander.**

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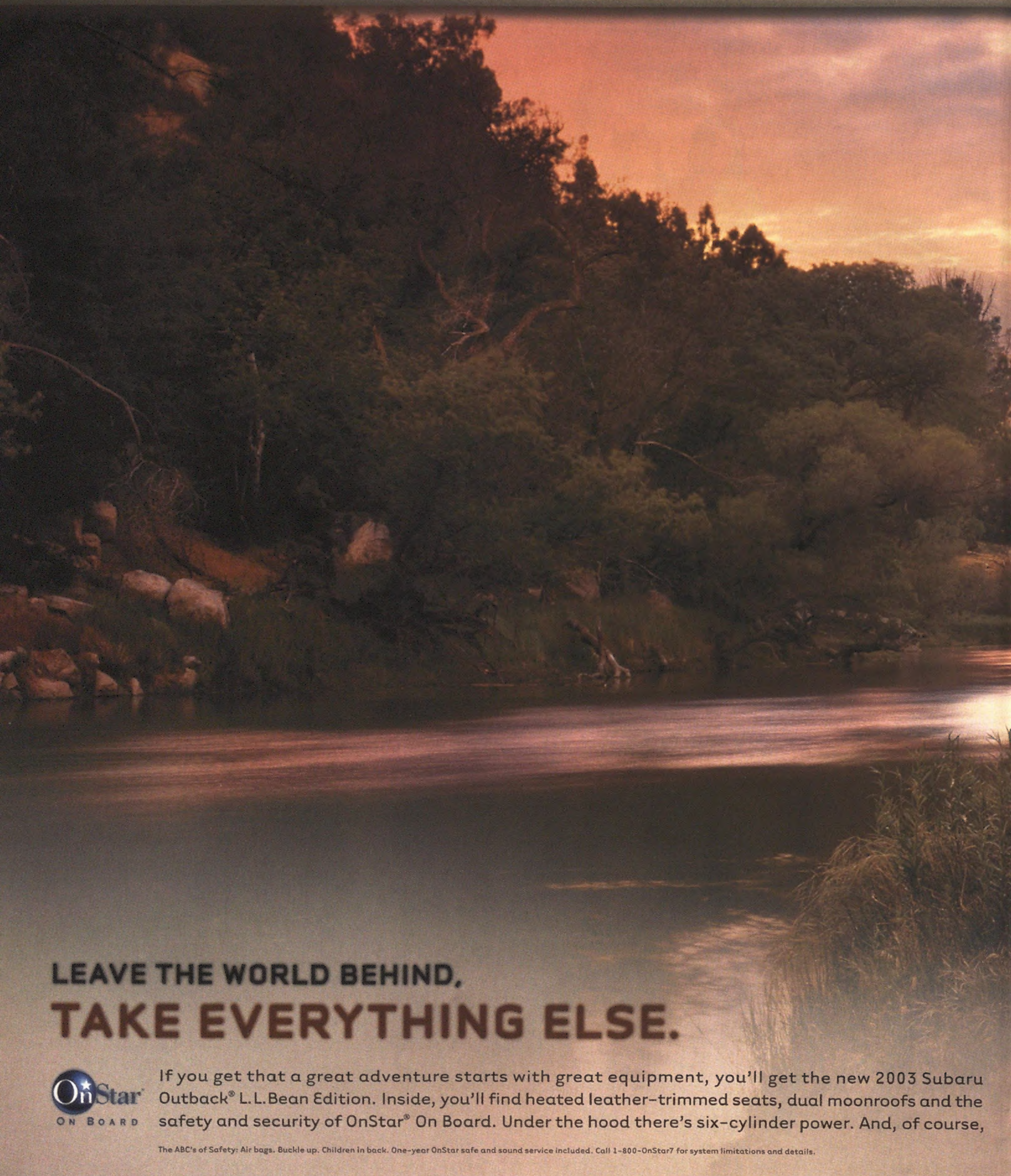

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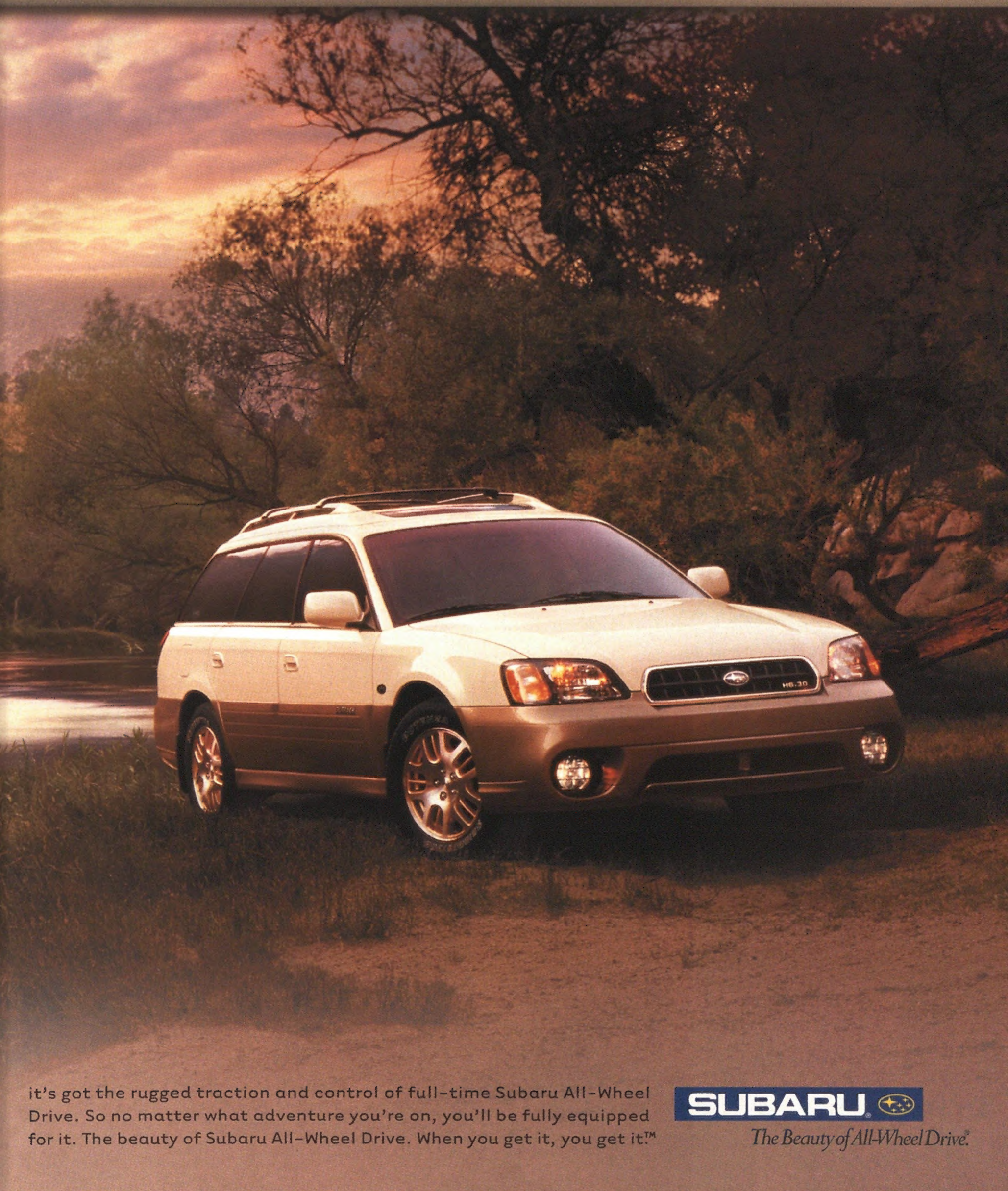

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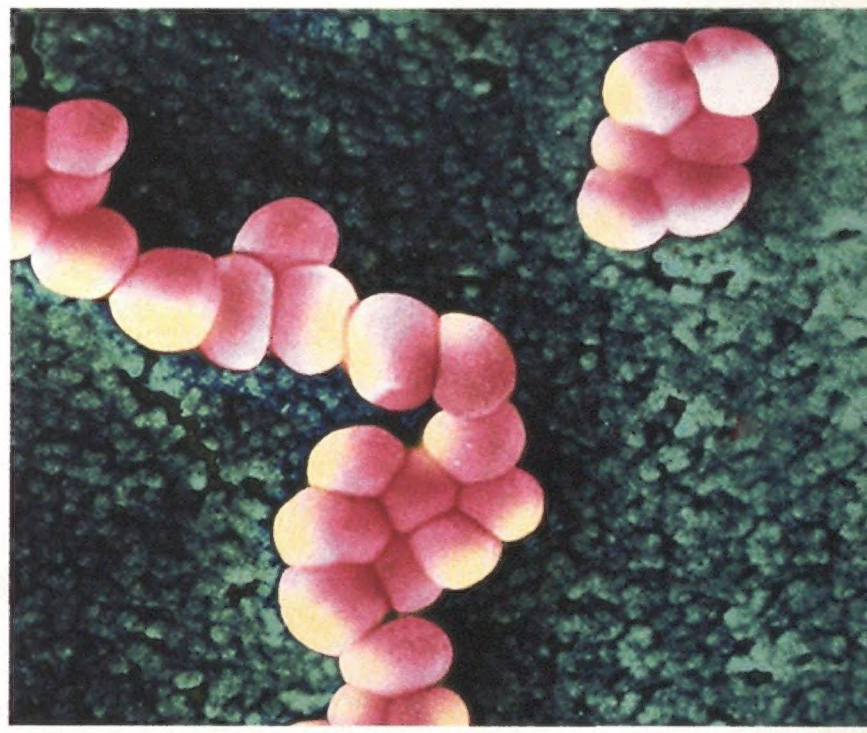

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From top: A kakapo chick preens; some strains of *Staphylococcus aureaus* have become resistant to antibiotics; engineers inspect the construction of the L.A. Aqueduct in 1905.

GIDEON CLIMO; BSIP/PHOTO RESEARCHERS; LOS ANGELES DEPARTMENT OF WATER AND POWER

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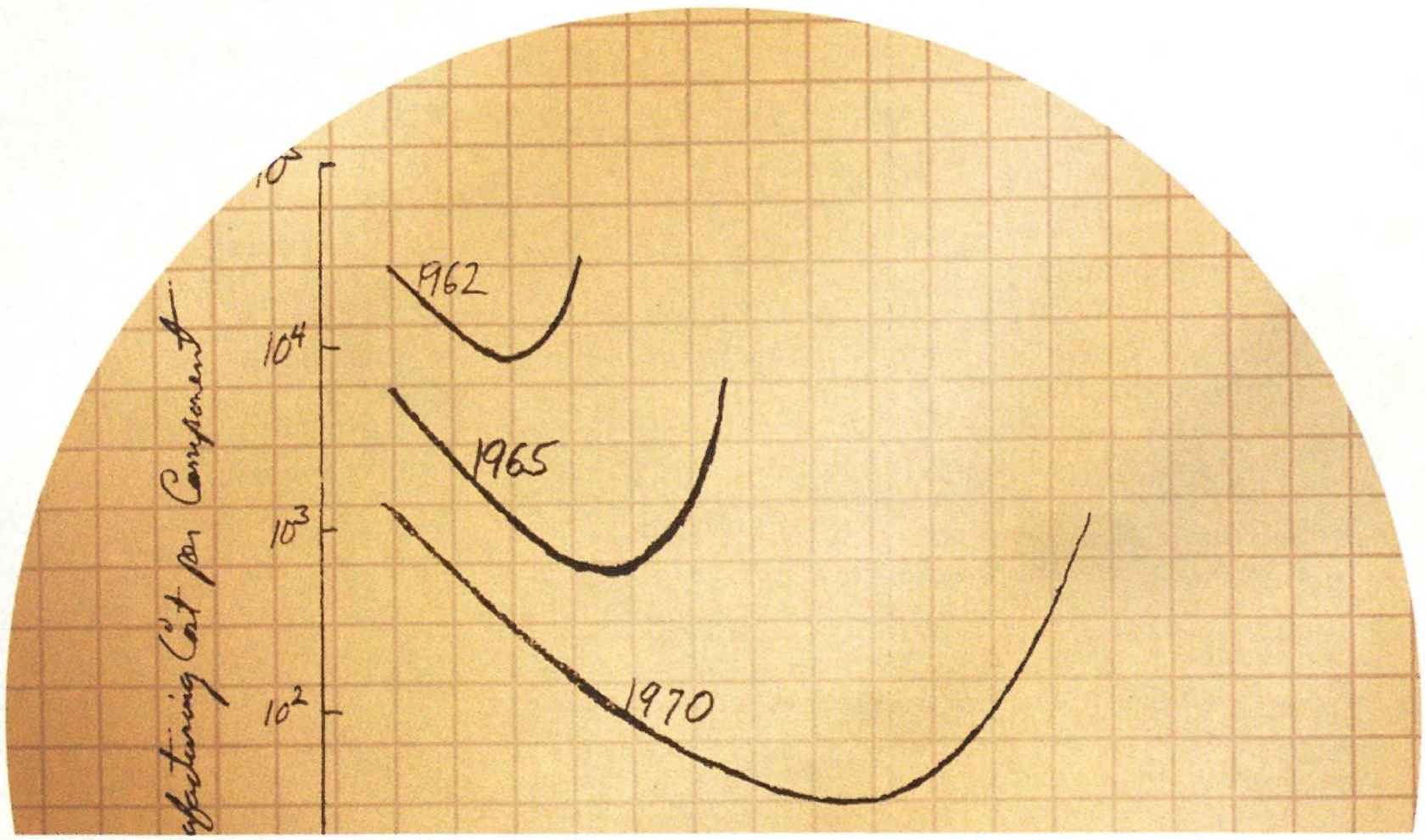

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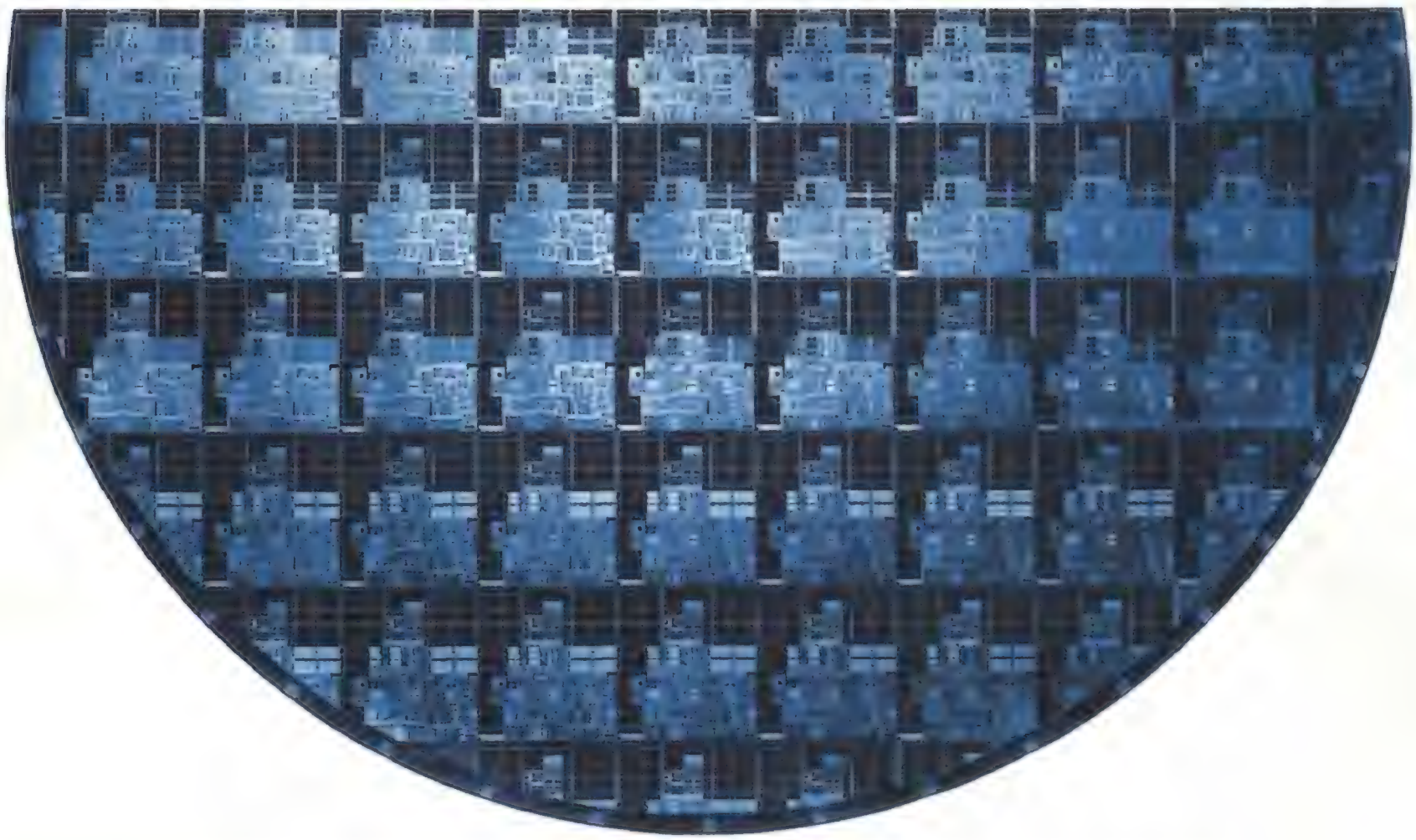

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NO, DEAR READER, THIS ISN'T *AUCKLAND TODAY*

BY CAREY WINFREY

YOU CAN'T HAVE TOO MANY STORIES ABOUT NEW ZEALAND, I ALWAYS SAY. At least I've said it a lot since I realized that three stories in this issue have ties to the island nation. Take "Going to Extremes" (p. 90), which documents the extraordinary efforts of scientists trying to save the kakapo, an extremely endangered flightless parrot in New Zealand. Then we have *two* stories about native sons of New Zealand's North Island (pop. 2.8 million). They are "Clutch Shot Clinches Fall Classic" (p. 25), about George Silk's exuberant photograph of the 1960 World Series, and "Politically Correct" (p. 96), about artist Peter Waddell's carefully researched—and charming—paintings of the U.S. Capitol.

How did we manage such a feat? Beats me, mate. In planning an issue, we try to achieve a perfect (and thus unattainable) balance of history, natural history, biography, science, the arts and travel, with a surprise or two thrown in. We also seek the right mixture of old and new, young and old, male and female, light and serious, and so on. But usually it's not until we pin all of the proofs of scheduled stories to a wall that we discover, say, an overabundance of Mississippi catfish, a surfeit of New England seafarers or . . . a Down Under trifecta. Not long ago, Michael Prager, of the *Boston Globe,* noted in a column that we'd used the word "physiognomy" in two stories in the same issue. (Doesn't every magazine?) Sometimes, if the coincidence is distracting, we'll substitute a different article at the last minute, but most of the time we just slap ourselves on the forehead and attribute it to the vagaries (and marvels) of chance in everyday life.

New Zealand: The vagaries of chance.

TOM VAN SANT/GEOSPHERE PROJECT/PLANETARY VISIONS/SPL/PHOTO RESEARCHERS

ON A MORE SERIOUS NOTE, I CALL YOUR ATTENTION TO "LESSONS FROM THE Missile Crisis" (p. 52), about the dangerous standoff, 40 years ago this month, between the United States and the Soviet Union over Soviet nuclear missiles in Cuba. The article was written by Max Frankel, who covered the crisis for the *New York Times* and was unusually well qualified to do so, having previously been stationed in the newspaper's Moscow and Havana bureaus. Frankel went on to become the *Times*' executive editor, the paper's highest editorial position. He was a direct observer of the events of October 1962—indeed, he participated in history as it unfolded, as he recounts here. His look back at that parlous moment is deeply instructive, for both the similarities and differences between then and our own fraught time.

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www.toyota.com/tomorrow

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Bats Will Scatter

FROM THE SECRETARY

AS MICHELANGELO COULD EYE A BLOCK OF MARBLE and see David, so Smithsonian taxidermists John Matthews and Paul Rhymer can spot the life in a wedge of polyurethane foam. The yellowish polymer is for them the stuff of faces and necks, limbs and paws and haunches. In a vast, faceless box of a building 20 highway minutes south of Washington, D.C., Matthews and Rhymer are preparing the hundreds of specimens that will be exhibited in the National Museum of Natural History's new Hall of Mammals. It's a labor daunting enough to win sympathy even from Noah. (The hall, which will open late next year, is but one of many improvements to the Smithsonian made possible by the generosity of California philanthropist Kenneth Behring.)

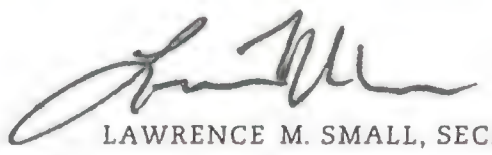
The Greek roots of the word "taxidermy" are straightforward as to its meaning: *taxis* for arrangement and *derma* for skin. The taxidermist tans the skins of animals and mounts them on man-made forms—the trade's own mannequins. The forms over which the treated skins are stretched, fitted and sewn were once papier-mâché, but for the past several decades they've generally been made of polyurethane foam. You can order them complete from taxidermy supply houses, whose catalogs offer most species. The entirely bare likenesses look at once familiar and unearthly on the page, and even more startling right in front of you. Or you can order à la carte: limb, head, ear, eye. Look into a drawer of the old wooden card catalog Matthews and Rhymer use for storage and the contents look right back at you: dozens of glass eyes attached like fancy colored buttons to strips of cardboard.

Using their protean foam, Matthews and Rhymer often alter a supplier's form to accommodate the particular skin it will hold or pose it will assume. The zebra mannequins purchased from a catalog, for example, need enlarging to become the majestic Grevy's zebras that will be featured in the forthcoming exhibition. Sometimes the taxidermists simply bypass the catalogs. On a shelf in the studio lies a collection of inch-or-two-long bits of Styrofoam attached to popcorn-size pieces of auto-body filler. They look like—well, nothing at all. But the Styrofoam pieces are bodies and the kernels of filler are heads, and when Matthews and Rhymer are finished, the bits will all be bats.

A star in stripes: Paul Rhymer and John Matthews prep a zebra for display in the new mammal hall.

Some specimens for the new hall were previously exhibited in the Natural History Museum, and these "old mounts"—a number of them irreplaceable because the species are extinct—will be cleaned and restored. (A panda in particular looks in need of a makeover, or, at the least, a good shampoo.) Matthews and Rhymer will give other old mounts a new attitude: through a strategic adjustment of limbs, for example, a running oryx will be brought to a halt and made a nursing oryx. But most specimens will be new. Indeed, the museum has a wish list of species it still needs—mongooses, for one—and has asked zoos around the world to notify the Smithsonian when animals that might have a place in the exhibition die.

Rhymer and Matthews are scrupulous about detail. (Rhymer continues a family tradition at the Institution, where his father also was a taxidermist and his grandfather an illustrator and exhibition designer.) After all, one animal may represent a species; to portray it truly is to respect the species. Both men speak of the need to get right such characteristics as the precise angle of an eye in a head and the exact location of a pupil in an eye, the depth of wrinkles in a snout and the differing definition of muscles on a haunch when an animal runs or rests. Through their painstaking craft, they give creatures an idealized existence after death; capture images that just happen to have all the dimensions of life. They persuade an observer that an animal's energy has been only temporarily contained. In another instant, life will resume: the giraffe will promenade; the zebra will paw the earth, the wildcat will spring, and those tiny bats will scatter to the sky.



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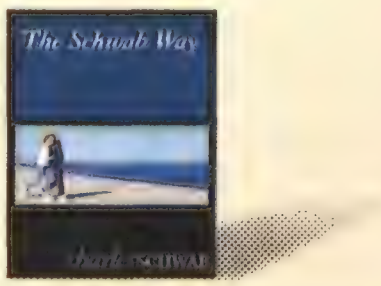

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Readers respond to the August issue.

THE SOUND OF SONDHEIM

WHEN I WAS READING "SONDHEIM!," Chip Brown's entertaining piece about Stephen Sondheim, a question that has nagged at me for 18 years kept recurring: What is it about *Sunday in the Park with George* that makes people fall apart? My wife and I saw it in New York in 1984, and the tear ducts opened early, when Mandy Patinkin sang "I could look at her forever." I composed myself for Act II, but when Bernadette Peters and Patinkin launched into "Move On," I was a goner and didn't stop crying until 20 minutes after the curtain calls. Over the years, I've found a number of Sondheim fans who reported similar reactions. What's going on? I like to think it's a complex, possibly subconscious, primal reaction to great art, or at least terrific music.

John M. Pope
New Orleans, Louisiana

SONDHEIM WON AN OSCAR FOR HIS work on *Dick Tracy*, but it was for the song "Sooner or Later," not the score. The talented composer Danny Elfman scored the film.

Amber Berebitsky
Tualatin, Oregon

I MOST ASSUREDLY ENJOY SONDHEIM, but leaving the theater after one of his shows, I am sometimes "starry-eyed" but always "vaguely discontented." Although there is no one in the musical theater today who more expertly presents the painful human dilemma of being up a tree, there appears to be precious little hope in his works of anything else. We are left to ask, "Is this all there is?" Sondheim apparently answers in the affirmative.

Robert E. Henry, Jr.
Oxnard, California

CLARK AFTER LEWIS

AMBIGUOUS WORDING IN "IRON WILL," about William Clark after his explorations with Meriwether Lewis, may support a myth long discredited by historians and anthropologists. The article states that Clark "thought that relocation to Indian country . . . would buy [Native Americans] time to develop the farming skills necessary to adapt to the white man's world." But most of the tribes exiled to Indian Territory were already agriculturalists, as were

the tribes displaced and driven to their deaths along the Trail of Tears.

S. L. Spurgeon
Tucson, Arizona

Author Landon Jones replies: Indians certainly cultivated corn, beans and pumpkins, among other plants, before they saw white men. Clark wanted them to broaden their base to include raising livestock and using more tools like the plow.

I CANNOT FATHOM WHY YOU WANTED to resurrect Clark, whose behavior seems to have been as bad as his spelling. From the article, he arguably did more to injure the Native Americans than any other individual in history.

Ruth G. Reichbart
Ridgewood, New Jersey

"IRON WILL" WAS ONE OF THE FINEST articles I've read in a long time. I am deeply touched by the sadness and torture suffered by the Indian people.

Sheron Schaeferle
Marissa, Illinois

THE BRITISH WERE NOT DEFEATED IN the War of 1812, as your article states, and neither were the Americans. It was a stalemate. The British probably got the better of the fighting, except for some smaller naval engagements and, after the war, the Battle of New Orleans. The two sides settled their differences by vigorous debate at Ghent.

Robert G. Walton
Modesto, California

DUTCH TREAT

"ODD DUKW" REMINDED ME OF my youth in Amsterdam. In 1945, at age 15, I returned to the city from northern Holland where I had lived for a year to escape the German-imposed starvation of civilians. While food was still quite scarce and the ugly signs of five years of Nazi rule were all around, we children were treated with DUKW rides through the canals of Amsterdam by the Canadian liberators. I can still remember the sense of freedom I felt, which contributed greatly to my decision to emigrate nine years later.

Arnoldus J. Gruter
Mankato, Minnesota

MUHAMMAD'S FAMILY

IN "EPIC IMAGES," ABOUT THE 16TH-century Mughal masterpiece, the Hamzanama, the misidentification of the prophet Muhammad's (peace and blessing be upon him) uncle as his nephew is a significant mistake. Getting the facts straight will enhance understanding and coexistence between peoples of different faiths.

Haron Amin
Embassy of Afghanistan
Washington, D.C.

We regret the editing error. Ed.

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Brief Summary (For full Prescribing Information, see package insert.)

INDICATIONS AND USAGE: Allergic Rhinitis: CLARINEX Tablets 5 mg are indicated for the relief of the nasal and non-nasal symptoms of allergic rhinitis (seasonal and perennial) in patients 12 years of age and older.

Chronic Idiopathic Urticaria: CLARINEX Tablets are indicated for the symptomatic relief of pruritus, reduction in the number of hives, and size of hives, in patients with chronic idiopathic urticaria 12 years of age and older.

CONTRAINDICATIONS: CLARINEX Tablets 5 mg are contraindicated in patients who are hypersensitive to this medication or to any of its ingredients, or to loratadine.

PRECAUTIONS: Carcinogenesis, Mutagenesis, Impairment of Fertility: The carcinogenic potential of desloratadine was assessed using loratadine studies. In an 18-month study in mice and a 2-year study in rats, loratadine was administered in the diet at doses up to 40 mg/kg/day in mice (estimated desloratadine and desloratadine metabolite exposures were approximately 3 times the AUC in humans at the recommended daily oral dose) and 25 mg/kg/day in rats (estimated desloratadine and desloratadine metabolite exposures were approximately 30 times the AUC in humans at the recommended daily oral dose). Male mice given 40 mg/kg/day loratadine had a significantly higher incidence of hepatocellular tumors (combined adenomas and carcinomas) than concurrent controls. In rats, a significantly higher incidence of hepatocellular tumors (combined adenomas and carcinomas) was observed in males given 10 mg/kg/day and in males and females given 25 mg/kg/day. The estimated desloratadine and desloratadine metabolite exposures of rats given 10 mg/kg of loratadine were approximately 7 times the AUC in humans at the recommended daily oral dose. The clinical significance of these findings during long-term use of desloratadine is not known.

In genotoxicity studies with desloratadine, there was no evidence of genotoxic potential in a reverse mutation assay (*Salmonella/E. coli* mammalian microsome bacterial mutagenicity assay) or in two assays for chromosomal aberrations (human peripheral blood lymphocyte clastogenicity assay and mouse bone marrow micronucleus assay).

There was no effect on female fertility in rats at desloratadine doses up to 24 mg/kg/day (estimated desloratadine and desloratadine metabolite exposures were approximately 130 times the AUC in humans at the recommended daily oral dose). A male specific decrease in fertility, demonstrated by reduced female conception rates, decreased sperm numbers and motility, and histopathologic testicular changes, occurred at an oral desloratadine dose of 12 mg/kg in rats (estimated desloratadine exposures were approximately 45 times the AUC in humans at the recommended daily oral dose). Desloratadine had no effect on fertility in rats at an oral dose of 3 mg/kg/day (estimated desloratadine and desloratadine metabolite exposures were approximately 8 times the AUC in humans at the recommended daily oral dose).

Pregnancy Category C: Desloratadine was not teratogenic in rats at doses up to 48 mg/kg/day (estimated desloratadine and desloratadine metabolite exposures were approximately 210 times the AUC in humans at the recommended daily oral dose) or in rabbits at doses up to 60 mg/kg/day (estimated desloratadine exposures were approximately 230 times the AUC in humans at the recommended daily oral dose). In a separate study, an increase in preimplantation loss and a decreased number of implantations and fetuses were noted in female rats at 24 mg/kg (estimated desloratadine and desloratadine metabolite exposures were approximately 120 times the AUC in humans at the recommended daily oral dose). Reduced body weight and slow righting reflex were reported in pups at doses of 9 mg/kg/day or greater (estimated desloratadine and desloratadine metabolite exposures were approximately 50 times or greater than the AUC in humans at the recommended daily oral dose). Desloratadine had no effect on pup development at an oral dose of 3 mg/kg/day (estimated desloratadine and desloratadine metabolite exposures were approximately 7 times the AUC in humans at the recommended daily oral dose). There are, however, no adequate and well-controlled studies in pregnant women. Because animal reproduction studies are not always predictive of human response, desloratadine should be used during pregnancy only if clearly needed.

Nursing Mothers: Desloratadine passes into breast milk, therefore a decision should be made whether to discontinue nursing or to discontinue desloratadine, taking into account the importance of the drug to the mother.

Pediatric Use: The safety and effectiveness of CLARINEX Tablets in pediatric patients under 12 years of age have not been established.

Geriatric Use: Clinical studies of desloratadine did not include sufficient numbers of subjects aged 65 and over to determine whether they respond differently from younger subjects. Other reported clinical experience has not identified differences between the elderly and younger patients. In general, dose selection for an elderly patient should be cautious, reflecting the greater frequency of decreased hepatic, renal, or cardiac function, and of concomitant disease or other drug therapy. (see **CLINICAL PHARMACOLOGY – Special Populations**).

Information for Patients: Patients should be instructed to use CLARINEX Tablets as directed. As there are no food effects on bioavailability, patients can be instructed that CLARINEX Tablets may be taken without regard to meals. Patients should be advised not to increase the dose or dosing frequency as studies have not demonstrated increased effectiveness at higher doses and somnolence may occur.

ADVERSE REACTIONS: Allergic Rhinitis: In multiple-dose placebo-controlled trials, 2,834 patients received CLARINEX Tablets at doses of 2.5 mg to 20 mg daily, of whom 1,655 patients received the recommended daily dose of 5 mg. In patients receiving 5 mg daily, the rate of adverse events was similar between CLARINEX and placebo-treated patients. The percent of patients who withdrew prematurely due to adverse events was 2.4% in the CLARINEX group and 2.6% in the placebo group. There were no serious adverse events in these trials in patients receiving desloratadine. All adverse events that were reported by greater than or equal to 2% of patients who received the recommended daily dose of CLARINEX Tablets (5.0 mg once-daily), and that were more common with CLARINEX Tablet than placebo, are listed in Table 5.

Table 5

Incidence of Adverse Events Reported by ≥ 2% of Allergic Rhinitis Patients in Placebo-Controlled, Multiple-Dose Clinical Trials

Adverse Experience	CLARINEX Tablets 5 mg (n=1,655)	Placebo (n=1,652)
Pharyngitis	4.1%	2.0%
Dry Mouth	3.0%	1.9%
Myalgia	2.1%	1.8%
Fatigue	2.1%	1.2%
Somnolence	2.1%	1.8%
Dysmenorrhea	2.1%	1.6%

The frequency and magnitude of laboratory and electrocardiographic abnormalities were similar in CLARINEX and placebo-treated patients.

There were no differences in adverse events for subgroups of patients as defined by gender, age, or race.

Chronic Idiopathic Urticaria: In multiple-dose, placebo-controlled trials of chronic idiopathic urticaria, 211 patients received CLARINEX Tablets and 205 received placebo. Adverse events that were reported by greater than or equal to 2% of patients who received CLARINEX Tablets and that were more common with CLARINEX than placebo were (rates for CLARINEX and placebo, respectively): headache (14%, 13%), nausea (5%, 2%), fatigue (5%, 1%), dizziness (4%, 3%), pharyngitis (3%, 2%), dyspepsia (3%, 1%), and myalgia (3%, 1%).

The following spontaneous adverse events have been reported during the marketing of desloratadine: tachycardia, and rarely hypersensitivity reactions (such as rash, pruritus, urticaria, edema, dyspnea, and anaphylaxis), and elevated liver enzymes including bilirubin.

DRUG ABUSE AND DEPENDENCE: There is no information to indicate that abuse or dependency occurs with CLARINEX Tablets.

OVERDOSAGE: Information regarding acute overdosage is limited to experience from clinical trials conducted during the development of the CLARINEX product. In a dose ranging trial, at doses of 10 mg and 20 mg/day somnolence was reported.

Single daily doses of 45 mg were given to normal male and female volunteers for 10 days. All ECGs obtained in this study were manually read in a blinded fashion by a cardiologist. In CLARINEX-treated subjects, there was an increase in mean heart rate of 9.2 bpm relative to placebo. The QT interval was corrected for heart rate (QT_c) by both the Bazett and Fridericia methods. Using the QT_c (Bazett) there was a mean increase of 8.1 msec in CLARINEX-treated subjects relative to placebo. Using QT_c (Fridericia) there was a mean increase of 0.4 msec in CLARINEX-treated subjects relative to placebo. No clinically relevant adverse events were reported.

In the event of overdose, consider standard measures to remove any unabsorbed drug. Symptomatic and supportive treatment is recommended. Desloratadine and 3-hydroxydesloratadine are not eliminated by hemodialysis.

Lethality occurred in rats at oral doses of 250 mg/kg or greater (estimated desloratadine and desloratadine metabolite exposures were approximately 120 times the AUC in humans at the recommended daily oral dose). The oral median lethal dose in mice was 353 mg/kg (estimated desloratadine exposures were approximately 290 times the human daily oral dose on a mg/m^2 basis). No deaths occurred at oral doses up to 250 mg/kg in monkeys (estimated desloratadine exposures were approximately 810 times the human daily oral dose on a mg/m^2 basis).

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. . . and from the July issue:

STORM OVER HEYERDAHL

RICHARD CONNIFF'S ARTICLE "KON Artist?" in the July issue, presents the late Thor Heyerdahl as a fraud, cheat and liar, which couldn't be further from the truth. I find it reprehensible that Conniff, on hearing of Thor's passing, dredged up a ten-year-old conversation with a Rapa Nui (formerly Easter Island) carver of fakes. The real con artist is not Heyerdahl but Pedro Pate, who, through greed, perpetrated this fraud which Conniff and SMITHSONIAN have twisted into stating that Heyerdahl was a fraud as well! Even the tone of the article is sickening, deprecating the integrity of Heyerdahl. What of all the other astounding things Heyerdahl accomplished in his 66 years of research?

James Richardson III, PhD
University of Pittsburgh
Pittsburgh, Pennsylvania

I WORKED WITH THOR Heyerdahl as his personal assistant and research associate over the past several years, and to suggest that Thor was involved in some sort of hoax or fraud is libelous. He had no need to "turn up the pressure to get the story" in order to "gratify the sponsors." He financed the expedition himself with his earnings from the best-selling book *Kon-Tiki*.

Nor did Thor believe that the Polynesians came from South America or were South Americans. This rampant misconception is easily dispelled by anyone who has read his massive scientific treatise, *American Indians in the Pacific*. Thor believed that people from South America had been involved in the Pacific Islands but never doubted that the Polynesians themselves had their ultimate origins in Southeast Asia.

One may disagree with Heyerdahl's various arguments and conclusions, but to impugn his reputation in this manner is to malign a beloved figure whose positive contributions to our world were numerous. I am confident that his themes and ideas will ultimately be found to be more correct than not.

Donald P. Ryan, PhD
Pacific Lutheran University
Tacoma, Washington

Thor Heyerdahl: larger than life

Richard Conniff responds: I understand the outrage and disappointment of readers who regard Heyerdahl as a hero, as I once did. But emotions do not alter the facts. On Easter Island, I spoke with numerous individuals who told me of fabricating statues with Heyerdahl's apparent complicity. Moreover, I found in his academic writings and his popular work repeated instances in which he ignores or distorts evidence to support his South American hypothesis. I also interviewed many anthropologists who regard Heyerdahl's work with skepticism at best. Some readers have suggested that it was scurrilous to wait until Heyerdahl was dead before publishing my essay. In fact, I published many of the same allegations almost ten years ago. Heyerdahl expressed outrage, but did not deign to refute my reporting. The death of a prominent individual is a legitimate occasion for reviewing his accomplishments, and I stand by my assessment: Heyerdahl was a larger-than-life figure whose achievements are permanently tainted by questionable scholarship and wishful thinking.

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The shot heard (and seen) round the world: Bill Mazeroski's ninth-inning homer wins the 1960 World Series for the Pittsburgh Pirates.

Clutch Shot Clinches Fall Classic

BY MICHAEL SHAPIRO

INDELIBLE IMAGES

NEW YORK YANKEE RALPH TERRY HAS JUST thrown the last pitch of the 1960 World Series. Pittsburgh Pirate Bill Mazeroski has just hit it. Far above them, on the roof of the Cathedral of Learning at the University of Pittsburgh, is George Silk. He does not like crowds. He is a sports photographer almost by default. "I hated stadiums and I couldn't work with all that noise in my ears," he once said.

On the roof he finds young men and women who are about to witness the most dramatic conclusion to a World Series in baseball history. It is the seventh and deciding game, the bottom of the ninth inning. The score is tied 9 to 9 when Mazeroski comes to bat. He takes Terry's first pitch for a ball. Later, Terry would say that he was not sure what kind of pitch he threw next, only that it was the "wrong" one. Mazeroski meets it flush. Yogi Berra, playing left field, hurries to the fence, but that only affords him a closer view of Mazeroski's championship-clinching home run.

Other photographers capture Mazeroski circling the bases, hands raised in triumph, or his Pirate teammates waiting for him at home. Silk's interest lies elsewhere. He is not looking at the action. He is not even looking at faces. The photograph, published in *Life* and a popular poster to this day, instead documents a quintessentially American moment—baseball, youth, sun and joy—though Silk is an

GEORGE SILK/TIMEPIX

Viewed from the spot (left) where Silk made his picture, University of Pittsburgh buildings now occupy the site of the old Forbes Field. At 85, Silk (right, at home in Connecticut) is known for helping break the sports photography mold, as in his 1962 photograph below.

immigrant with only scant knowledge of baseball.

Silk had made his reputation as a combat photographer. Born in Levin, New Zealand, in 1916, he had been taking pictures for the Australian government when, in 1942, he photographed a blinded Australian soldier being led by a villager in New Guinea. Officials censored the picture, but a *Time* correspondent sent it to New York and *Life* published it—an image that Australians recognize as one of the most important photographs of the war. Silk went on to take many combat photographs for *Life*, and grew so used to the front lines, he later said, that he felt "lost" when the war ended.

Silk, who has lived in the United States since 1947, is retired in Westport, Connecticut. (For their parts, ex-Yankee Terry left baseball in 1967, became a golf-club professional and lives in Kansas. Mazeroski stopped playing for the Pirates in 1972 and coached for many years. He lives in Pittsburgh.) Silk recalled to John Loengard, author of the 1998 book *Life Photographers,* that he "got involved in photographing sports without really knowing I was doing it." In the late 1950s, Silk began experimenting with high-speed electronic flash, panoramic cameras and narrowed lens openings, or slits (see page 132, bottom). For one uncanny wilderness shot, he put a camera in a glass box, placed it in a stream, and hid nearby for a week until a deer and a trout both wandered into the frame, when he tripped the shutter by remote control. In another famous shot, he photographed a young high-diver as she pierced the water's surface in a riot of bubbles. Silk helped break the formulas of sports photography, says Gael Newton, a photography curator at the National Gallery of Australia, Canberra, which in 2000 exhibited Silk's work. His photographs, Newton adds, often have "layers of meaning beneath their élan and . . . technical novelty."

Silk does not recall what, precisely, drew him to the top of the Cathedral of Learning on October 13, 1960. It just seemed the best place to be, he says. He could not have anticipated the enduring power of the image. For here is a picture that baseball has, in a sense, been feeding on for two generations. Forbes Field sits in the distance, so hazy that it could be a dream. In the foreground are fans who, in their sport coats and dresses, project the cleanliness and propriety that baseball has always tried to cultivate if only as a counterweight to the rougher reputation of the men who played the game. Something about the image remains alluring, even haunting: Is it the idea that things in America, as typified by the national pastime, were better then?

In the midst of America's move from the cities to the suburbs, downtown stadiums like Forbes Field succumbed to the wrecker's ball, dismissed as too old and too cramped. By 1971, the next time the Pirates were in a World Series, they had relocated to Three Rivers Stadium, one of the new, vast modern arenas that would become the rage.

The Pirates, however, no longer play at Three Rivers but in yet another new stadium, PNC Park. Like other ballparks built in recent years, it was designed to evoke the feel of places like Forbes Field. The smaller parks bring spectators close to the action. They create an intimacy seldom felt in the stadiums they replaced. They try to re-create a time that George Silk captured one October day 42 years ago.

Michael Shapiro teaches journalism at Columbia University and is completing a book about the 1956 Brooklyn Dodgers.

MATT BULVONY; GALE ZUCKER; GEORGE SILK/TIMEPIX

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THE OBJECT AT HAND

Pack Rat

FIRST VIRGIL JOHNSON GAVE UP SMOKING. THEN HE GAVE UP HIS BREATHTAKING COLLECTION OF TOBACCO-NALIA

BY ED LEIBOWITZ

The eye-catching cigarette packages in Johnson's collection served as advertisements as well as containers, testaments to legions of company artists. English Craven A's, American One-Elevens and Scottish Cuba Blends are from the first half of the 20th century.

AT THE HEIGHT OF THE DEPRESSION, A 15-YEAR-OLD caddie named Virgil Johnson picked up some discarded cigarette packages from the grassy expanse of Washington State's Wenatchee Golf and Country Club. With brand names like Murad and Melachrino, the packs evoked exotic, faraway places; though empty, they still bore the pungent aroma of Turkish tobacco. That was the beginning. Later, as a chief petty officer and combat photographer on a battleship in World War II, Johnson found himself in Cairo, where he went on a buying spree, collecting all sorts of brands, including one depicting a languid woman draped over a lion, into whose face she blows a column of smoke that spells out the cigarette maker's name.

More than a half-century later, Johnson, 84, offered the fruits of his long obsession to the Smithsonian's National Museum of American History, turning over about 6,000 cigarette packages, classified into 24 albums by manufacturer and country of origin from Afghanistan to Venezuela.

The collection, says Smithsonian curator David Shayt, "encompasses the vast acreage of tobacco history. What Virgil has done is to display the face of the tobacco industry as it presented itself to the consumer, in album after album, page after page, in a very organized, antiseptic and dispassionate way. He chronicles tobacco's rise and fall in a remarkably small space."

Johnson, who lives in Alexandria, Virginia, swore off cigarettes decades ago when he read about the Surgeon General's health warning (though he admits to an occasional cigar or pipe). He broke his vow of cigarette abstinence only once, to sample a pack of Southern Lights, a brand manufactured exclusively for state prisoners and sent to him by the Illinois Department of Corrections. The cigarettes, he concluded after a few puffs, "were a part of the punishment."

Over the years, Johnson became attuned to subtle and major shifts in cigarette advertising and packaging design. He points out, for instance, that Marlboros were marketed in the mid-1940s not for cowboy wanna-bes but for tenderfeet seeking "extreme mildness." The cigarettes even featured a "beauty tip," ruby-red edging at the unlighted end to better hide traces of a female smoker's lipstick. "The beauty tip didn't affect the taste at all," Johnson says, "but if you were a man and smoked the red-tipped ones, you'd encounter some raised eyebrows."

While cigarette manufacturers added lilac and rose perfume to attract female smokers, other additives were geared to both sexes. The Johnson collection documents cigarettes laced with rum, maple syrup, vermouth and honey. Lambert Pharmacal, makers of Listerine, once marketed a cigarette whose "cooling and soothing effect" was achieved by

VIRGIL JOHNSON COLLECTION, ARCHIVE CENTER NMAH, SI (3)

His years in the Navy gave Johnson opportunities to expand his collection.

"impregnating fine tobacco with the antiseptic essential oils used in the manufacture of Listerine." A Coffee-Tone brand attempted to combine two early morning vices by marrying "the flavor and aroma of selected coffees with the finest domestic and imported tobaccos." Says Johnson: "At the time, the manufacturers probably weren't getting very good tobacco. The flavoring could kill the poor tobacco taste."

Johnson's collection also recalls the days when movie stars such as Barbara Stanwyck, Lucille Ball, Ronald Reagan and Douglas Fairbanks, Jr., professed their devotion to Lucky Strikes or Chesterfields. An Algerian company featured Jean Harlow on their Star brand, and Head Play, an American brand, was named for the winner of the 1933 Preakness.

Postwar America saw the rise of Atom cigarettes with translucent tips banded in orange, green and gold, evoking the fluorescence of uranium. Politicians, including Presidents Eisenhower and George Bush the elder, were feted on election year packages. Some cigarette marketers even tried irony. A decade ago, Gridlock billed itself as "the commuter's cigarette." In 1960, "Philter" was true to its name: mainly a filter with only an inch of tobacco. "The world's most exhausting cigarettes," the package boasted, adding that "Philter smokers' butts are bigger."

Johnson says that package design became less elaborate in the 1960s, when fewer brands with Turkish tobacco meant less imagery beckoning smokers to foreign locales. "The new images weren't as colorful," he says. "The designs were more abstract."

In addition to the Smithsonian collection, Johnson also donated about 4,000 cigarettes to the Centers for Disease Control and Prevention for future research on tobacco and its uses. Sealed in glass vials, the cigarettes ensure that Johnson's lifelong avocation will not go up in smoke.

Ed Leibowitz, a writer at large for Los Angeles Magazine, *last wrote for* Smithsonian *on G.I. Joe action figures.*

MOLLY ROBERTS

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PHENOMENA

& CURIOSITIES

Net Gains

A CALIFORNIA BIOLOGIST DISCOVERED A NEW INSECT SPECIES AND THEN CAUGHT EVOLUTION IN THE ACT

BY DEBORAH FRANKLIN

"Fieldwork requires a butterfly net, vials, a notebook—and good eyes," says Sandoval.

WHAT A COMFORT IT IS, IN THIS techno-mad age, that a scientist can still do important research in her backyard with a butterfly net.

Cristina Sandoval was an ecology graduate student at the University of California, Santa Barbara when, net in hand, she headed into the chaparral-covered Santa Ynez Mountains near campus in search of a thesis. There, she slipped the net onto various shrub and plant branches, and then shook them to see what fell out. Along with a dusty trove of dried leaves, spiders and bird droppings, she collected an assortment of inch-long insects that looked like beady-eyed twigs—walkingsticks, distant cousins of crickets and cockroaches. In fact, she had discovered a new species of walkingstick, which, in keeping with taxonomic tradition, was named after her, *Timema cristinae*. "I felt proud," she said of the honor, adding that it gave her a sense of immortality and even made her feel protective of her six-legged namesake.

The achievement might seem quite sufficient for a scientist-in-training, but it was only the beginning. Braving poison oak, brambles, searing heat and rattlesnakes to observe her walkingstick in its scrubby habitat, baiting homemade traps to learn about its predators, and teaming with other scientists to glean its genetic makeup, Sandoval has pursued this unlikely creature for 13 years. She now believes that it offers a rare glimpse of the process that Charles Darwin famously called "the origin of species." The evidence she has gathered suggests that her walkingstick, because it is so intensely preyed upon by lizards and birds, is on the verge of making biology's biggest leap by splitting into two distinct species—a phenomenon that scientists have long puzzled over but seldom observed directly.

"One of the biggest questions in biology is, how are species formed?" says Sandoval, 41, who got her doctorate in 1993 and is now director of the Coal Oil Point Reserve, a university-affiliated wildlife refuge in Santa Barbara. "It's just in us to want to figure out what's going on in nature to create the amazing diversity we see." Like other walkingsticks, the *T. cristinae* can't fly, lives only a few months and spends most of its daylight hours standing perfectly, boringly still. It ranges across the West, Sandoval says, and is plumper and has shorter legs than other walkingsticks, and the male's genitals are distinctive. But the main reason that Sandoval has studied the insect so intensively is its coloration, which comes in two forms and varies according to

DAVID STRICK

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the type of bush the insect inhabits. Those that favor the ceanothus plant, which has yellowish green oval leaves, are themselves plain yellowish green; they like to rest in the middle of a ceanothus leaf. By contrast, a *T. cristinae* partial to the chamise bush, which has dark green, needlelike leaves, bears a stripe on its back and straddles a leaf. In either case, the coloration renders the insect almost invisible to predators such as blue jays and lizards, as Sandoval found in field tests. When she placed striped or plain insects on a branch from their preferred bush, far fewer were gobbled up compared with those she put on branches of the "wrong" bush.

That a walkingstick is living camouflage is no surprise; after all, grade-school kids study the creature as one of nature's more blatant examples of adaptation. But Sandoval has taken the phenomenon to a new level. According to the standard view of adaptation, an individual with a defensive edge is more likely than a run-of-the-mill specimen to survive in a competitive bird-eat-bug world and pass on its genes to the next generation. But how does a variety distinguished only by a defense mechanism evolve into a new species that no longer mates with members of the species from which it sprang?

Part of the answer may reside in *T. cristinae*'s mating habits. A striped or plain variety tends to mate with its own kind, Sandoval and coworkers found, even though the insects have poor eyesight. The preference could be based on smell, she says, or a breakdown in the courtship ritual. When a male walkingstick wants sex, he crouches on top of the female and tickles her antennae with his own, while stroking her abdomen with his feet. If interested, she'll mate; if not, she'll push him away. "Maybe males of different varieties no longer have the right equipment," Sandoval says. "Maybe they don't do the right tickle."

Whatever cues the insects use, what's important is that, somehow, the genes that influence mating preferences are passed along with the genes that determine whether the walkingstick is striped or plain. Then predators brutishly reinforce the *T. cristinae*'s mating choices: offspring that are neither striped nor plain probably don't hide well and are easy pickings for lizards and birds. Offspring that do hide well survive, mate with their own kind, and so on. If, over time, instances of successful interbreeding between striped and plain varieties were to sink to close to zero, then two species would exist instead of one.

Since Darwin, biologists have generally believed that new species form in nature after some singular chance event. But Sandoval and coworkers recently reported evidence quite to the contrary, showing that striped and plain varieties were popping up all over the hills. Working with molecular biologists at Simon Fraser University in British Columbia, she sampled DNA from several populations of striped and plain walkingsticks on a Santa Ynez slope. She

Shown about twice their normal size, a plain *cristinae* walkingstick (left) prefers the ceanothus plant for blending in, while the striped variety (right) seeks out the needlelike leaves of the chamise.

found that a striped and a plain walkingstick from the same bush are more closely related to each other than they are to walkingsticks of similar appearance that live several bushes away. Plain green and striped walkingsticks are continuously being born on, say, the flat-leafed bush. But plain green *cristinae* end up predominating because predators wipe out most of the striped individuals.

That's big news to evolutionary biologists, who have long believed that two groups from one species would have to be separated by vast barriers of geography and time—an ocean or mountain range, for example, and perhaps thousands of years—before they would evolve to the point where they would not or could not interbreed. The finding that the two visually distinct varieties of *T. cristinae* arose not once, but multiple times in bush after bush, is a strong sign that no geographic barrier or imponderable period of time is necessary for speciation.

Dolph Schluter, an evolutionary biologist at the University of British Columbia in Vancouver, has found similar results in his studies of stickleback fish. He says the walkingstick findings are "extremely cool" because they combine DNA technology with old-fashioned fieldwork to reveal the inner workings of evolution, which are usually too slow to observe.

Sandoval says there's no substitute for beating the bushes. "To be a good naturalist you have to go out in the field with your eyes wide open," she says. "You have to pay attention to develop intuition. Analytic skills are important, and so is luck. But intuition is crucial, so that you're always ready to pursue what luck turns up."

Deborah Franklin, a former senior writer for Fortune, *covers science, medicine and culture from San Francisco.*

CRISTINA SANDOVAL (2)

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POINTS OF INTEREST

Making Ends Meet

IOWA ABBEY MONKS CRAFT FINE CASKETS FOR THE RECENTLY DEPARTED AND "PRE-NEED" CUSTOMERS ALIKE

BY SAM HOOPER SAMUELS

New Melleray carpenters (layman Tim Ruden, left, and Father Phil Shangraw) produce some 450 Trappist caskets annually, from trees on the abbey's 3,400-acre property.

MONDAYS ARE OFTEN HECTIC IN the casket business, and today is no exception. By 10:00 A.M., the company has one premium black walnut casket, a shaped oak and a shaped pine to get out the door. Pickup time is 2:00 P.M., which will be tight. Arturo, Aiden and Paul have to pull the caskets from high warehouse racks, pack them in Styrofoam-lined cardboard boxes, seal the lids with nylon straps, affix bills of lading, and move the merchandise out to the loading dock. With Arturo's back acting up again, the going could be slow. And at 11:30 A.M. sharp, as usual, the men will drop whatever they're doing and go to the chapel to pray.

Monks are like that.

Arturo Amos, Aiden Rachford and Paul Andrew Tanner are Trappist monks at New Melleray Abbey in Peosta, Iowa, outside Dubuque. Two and a half years ago, the abbey started Trappist Caskets, a venture that is partly an attempt to restore spirituality to the modern way of death and partly a bid to support the monastery's way of life.

New Melleray, an imposing limestone abbey founded 153 years ago by Irish monks, was once home to as many as 150 adherents but is now down to 38. "We've got four guys in their 90s," says Father Brendan Freeman, the abbot, adding that the monks' average age is 67. The Trappist order, which is Roman Catholic, dates to the mid-1600s, when it arose at a Cistercian monastery in La Trappe, France, and is formally known as the Order of Cistercians of the Strict Observance. The New Melleray monks arise at 3:15 each morning, attend church services seven times daily, refrain from eating meat, and emphasize the dignity of work, which is "the most effective way we can love and serve our brothers and sisters here and now," as one abbey bulletin puts it.

The primary source of outside income for the abbey, which is situated on 3,400 acres, is farming. The monks grow alfalfa, corn, soybeans, potatoes and oats. But as farm revenues fell and healthcare bills rose, the aging Melleray monks turned to one of the most notable and abundant features of their property: trees. Black walnut. Red oak. White oak. Ash. Maple. Pine. The mature hardwoods and softwoods wedged in among the fields constitute the second largest privately owned forest in Iowa.

Over the years, the monks have preserved their forests and even earned an award from the state in 1998 for their woodland management. But now they are harvesting the trees—though carefully, as 74-year-old Brother Placid Zilka demonstrated the other day.

As the abbey's procurator, he's responsible for the farm, forest, buildings and grounds. He looks as comfortable in his Iowa farmer's uniform of jeans, work shirt and billed cap as he is in the white habit, black scapular, leather belt

ALL: JAMES SCHNEPF

and sandals that he wears as a solemnly professed Trappist.

"See those pines, way up far?" Placid says, pointing through the windshield of the abbey's 1976 Ford pickup as he steers with his other hand along two muddy ruts that serve as a road. "Right on the horizon in there? I planted those. Those trees are harvestable." We get out of the truck and walk into the forest. Placid spots a young black walnut, a premium wood, right next to a box elder, a tree of no carpentry value that is hogging the sunlight. It's OK for now, Placid says, because the elder is forcing the walnut to grow straight and tall as it reaches for the light. Eventually the elder will be felled, and the walnut, if properly pruned, may someday fetch a small fortune from a veneer maker.

"Keep death before one's eyes daily," commands one of the rules by which the monks (like Father Brendan, above) live.

Placid stops before a mature tree, unfolds a pocketknife and slices into the bark, revealing the chocolate brown color that is the mark of black walnut. He wraps his arms around the trunk in a bear hug to size it up. He doesn't carry a tape measure. "This would probably be about a $4,000 log," if sold for veneer, he says. "We'll use its secondary logs for caskets and make a real good return."

Trappist caskets are less ornate and less expensive than commercial models, which often retail for $4,000 or $5,000. The premium Trappist casket, black walnut with raised paneling and mitered corners, costs $1,485. A plain pine box sells for $575. The monks also make coffins, shaped caskets widest at the shoulders. Handles and hinges are sturdy, without ornamentation. Instead of satin, Trappist caskets are lined with white muslin and padded with straw.

New Melleray monks, because they spend most of their time praying, studying or attending church, have only about five and a half hours a day to make caskets. They've had to hire several laypeople to keep production going, but the monks still do everything from milling the lumber to stapling casket upholstery. The woodshop is in a 100-year-old wood-framed building with tall windows located a few hundred yards from the abbey through a stand of pines. Waste is unheard of. Scrap wood is made into small furniture, crosses and clocks, which are for sale in the abbey gift shop. Odds and ends go into the wood chipper to make heating fuel, and sawdust is spread around the trees for mulch.

The business got off to a rocky start when the monks distributed the caskets through funeral homes, which tended not to push the monks' low-priced fare. Now they rely on word of mouth and sell directly to consumers through their Web site, www.trappistcaskets.com. Orders come from "pre-need" (industry jargon for "alive") customers as well as "need" customers. Clients have included several bishops and Cardinal Roger Mahony, archbishop of Los Angeles (pre) and a prominent peace negotiator in Ireland (need). For people ordering in advance who want the casket on hand, the monks will, upon request, fit it with shelves—the "book casket," originally ordered by a priest who "wants to enjoy his casket from this side of eternity," says the abbey newsletter. The other day, Sam Mulgrew, a layman and the company's business manager, got a rush order for a casket to be sent to Wrangell, Alaska, a town inaccessible by road. It arrived there by air charter. No Trappist casket has ever been late for a funeral.

Though the casket venture brings in money for the abbey, it also reflects Trappist beliefs and practices, which include an abiding awareness of death as a sacred, not-to-be-feared part of life. "Keep death before one's eyes daily," says one of the strictures of the 1,500-year-old Rule of Saint Benedict, which governs the monks' lives.

A few steps outside the abbey walls is the monks' own cemetery, where graves are marked by neat rows of iron crosses, about 150 in all. "There's a close connection between life and death," Father Brendan says. "I like to walk out there occasionally and just go from grave to grave. There's Father Shawn's cross, and Brother Fabian, and Brother Hilary, and Father Richard. Father Maurus and Brother George. My memories of them come back as I stand there." Then he visits the founders' graves. "There's Brother Ambrose out there, some of these guys who came over from Ireland in 1849. I kind of imagine what they might have been like. In a certain sense, we owe this whole place to these guys."

As it happens, they were each lowered into the ground in accordance with Trappist tradition, as Father Brendan himself expects to be—on an uncovered wooden platform, and not in a casket at all.

Sam Hooper Samuels is a freelance writer in Brattleboro, Vermont.

PEOPLE FILE

Rain Man

SNOW, SLEET, HAIL OR VOLCANIC ERUPTION—CLOUD PHYSICIST PETER HOBBS WILL FIND A WAY TO FLY INTO IT

BY DAVID LASKIN

Peter Hobbs has spent nearly four decades trying to do something about the weather.

PETER HOBBS LEANS TOWARD ME as if to shout over the roar of the bucking Convair 580 turboprop airplane when there's a tremendous bang, and a burst of orange fire flashes across the sky outside my window. I brace for a death spiral. Hobbs cracks a rare grin. "We just got hit by lightning," he announces with obvious delight.

As founder and head of the University of Washington's Cloud and Aerosol Research Group, Hobbs has spent the better part of a lifetime flying into some of the most horrendous weather conditions on the planet in a quest to understand the highly complex dynamics of snow, rain, sleet and hail.

Precipitation remains one of the great mysteries of the natural world. Difficult to predict accurately more than a day or two in advance, invisible in its origins, chaotic in its behavior, wet weather is only just beginning to yield its secrets to Hobbs and other scientists. The main puzzle, of course, is what causes it in the first place. Hobbs has spent nearly 40 years trying to figure this out and, in the process, has helped to forge the field of cloud microphysics. "To forecast precipitation—where and when it will form and at what intensity—you need a good understanding of the small-scale processes within clouds," he says. Better forecasting could enable farmers to harvest crops before they are damaged by hail or rain. Townships plagued by flooding could gain precious time to make preparations.

With his British accent and buttoned-down demeanor, Hobbs, 66, looks more like a Fleet Street banker than a daring adventurer. But it's clear that he shares a fierce dedication to his work. "In the old days," Hobbs says, "we'd apply gooey stuff to a stick and hold it outside the plane's open window until crystals formed on it. Then we'd pull it back into the plane, take it down, and analyze the crystals one by one under a microscope." Now, the Convair is jammed with more than $1 million worth of specialized equipment, including a Cloud Particle Imager (CPI), which has a digital camera that snaps 40 frames a second of ice crystals as small as ten microns, about one-tenth the width of a human hair.

As the aircraft continues to bounce through a storm at 15,000 feet over Washington State's coast, Hobbs stares at shapes resembling four-leaf clovers, fish tails and muffins dancing across the screen of his laptop—real-time renderings of the ice particles outside the aircraft. These are proto-raindrops, Hobbs explains, the seeds in upper reaches of clouds that, under the right conditions,

RICH FRISHMAN

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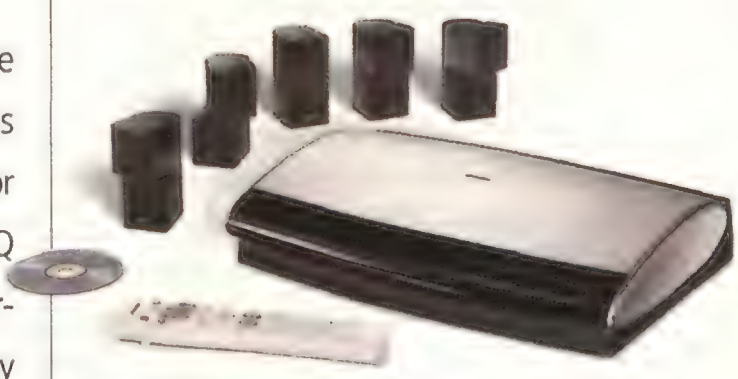

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will mass together to form small hailstones (known as graupel). When graupel falls from clouds and hits warmer air, it melts and creates raindrops. "At present, forecast models don't take into consideration what happens within the clouds," says Hobbs, "and that's what we're hoping to improve by studying how tiny cloud particles grow, and what role ice and snowflakes play in various types of weather systems."

HOBBS' FASCINATION WITH WEATHER started when he was a child in post-World War II England. Born in the London suburb of Richmond in 1936, Hobbs was evacuated to the north of England in 1943, and he says his education was pretty sketchy until he returned home at war's end two years later. "My parents were despairing of me," he recalls. Trying to rouse his interests, they sent him into London one day to visit an aunt who worked for the United Kingdom Meteorological Office. "She got the weather observer to take me onto the roof and show me how to make measurements using a psychrometer, anemometer and rain gauge. I was fascinated," he says. "Soon I had built my own weather station."

By the time he was 14, Hobbs knew he wanted to devote his life to investigating the elements. After attending a lecture on the physics of rainmaking by Sir John Mason, he approached the eminent British atmospheric scientist for career advice. "'You're a bit young,' Mason told me. 'Come back and see me when you have a degree in physics.' Ten years later I knocked on his door with my physics diploma from Imperial College in my hand. He took me on as a graduate student on the spot."

After receiving his PhD for research in cloud physics in 1963, Hobbs came to the University of Washington in Seattle as an assistant professor. He chose Seattle, he says, because it is the "cloud capital of the world."

Frustrated by having to conduct weather research from a subbasement lab on the University of Washington

As they flew 20 miles downwind of the volcano, explosions suddenly rattled the plane.

campus, Hobbs wangled a trip for himself and a team of graduate students to fly to a glacier on 7,965-foot-high Mount Olympus, where they could study clouds up close. That experience hooked him on the idea of using airplanes as mobile laboratories. By 1970 he had secured the use of a Douglas

Bird's-eye view: Hobbs' colleague Art Rangno gets up close and personal with thunderstorms in the Convair's bubble.

B-23 Dragon, a World War II-era patrol-and-training aircraft that had been owned by Howard Hughes and had seen action in war movies. The plane, bought by the university and supported by federal grants, gave Hobbs the freedom to investigate whatever weather phenomena piqued his curiosity, from the sulfur content of Arctic haze and the structure of ice crystals in Pacific winter storms, to the meteorological fallout of the more than 600 oil wells burning in Kuwait after the Gulf War.

Over the past 32 years Hobbs has circled the globe on three different aircraft he's outfitted with a raft of meteorological instrumentation, attempting to learn why precipitation arrives in distinct rainbands, how pollution affects rainfall, and the nature of the relationship between cloud processes and rainfall intensity.

Hobbs' customary reserve cracks again when he recounts a mad dash into the scalding plume of Mount Saint Helens as it spewed ashes several miles into the atmosphere on the morning of May 18, 1980. The volcano blew at 8:20 A.M. on a Sunday, and by 11 A.M. Hobbs and his crew were in the air and flying toward it.

"As we approached this monster, I could see that the huge plume looked like a cauliflower with each part heaving and turning," he recalls. As they flew 20 miles downwind, a volley of explosions suddenly rattled the plane. "I remember thinking we're being hit by rocks and we're dead," he says. "But it turned out to be volcanic hailstones—highly charged conglomerations of dust that fell apart when they hit the plane."

The noise was terrifying, but the aircraft sustained no significant damage. As the plume drifted into Idaho, Hobbs recorded some of the first quantitative measurements ever made of the carbon dioxide, water vapor and sulfur dioxide emitted by an erupting volcano.

Given his passion for flying into billows of smoke, volleys of volcanic hail and torrents of microscopic ice crystals, I was surprised to learn that the Convair had recently been sold. "I'll miss the excitement of doing fieldwork all around the world," he says. But he won't miss having to raise $2 million each year, most of it in grants, which he needs to fund his aerial projects.

Even so, Hobbs is adamant that he has no intention of coming in out of the rain. After all, he has accumulated enough data to keep him and his department squeezing secrets out of the clouds for at least the next ten years.

Seattle-based David Laskin wrote about the Weather Channel in April 1999.

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FLONASE®
(fluticasone propionate)
Nasal Spray, 50 mcg

BRIEF SUMMARY

For Intranasal Use Only. **SHAKE GENTLY BEFORE USE.**

The following is a brief summary only; see full prescribing information for complete product information.

CONTRAINDICATIONS

FLONASE Nasal Spray is contraindicated in patients with a hypersensitivity to any of its ingredients.

WARNINGS

The replacement of a systemic corticosteroid with a topical corticosteroid can be accompanied by signs of adrenal insufficiency, and in addition some patients may experience symptoms of withdrawal, e.g., joint and/or muscular pain, lassitude, and depression. Patients previously treated for prolonged periods with systemic corticosteroids and transferred to topical corticosteroids should be carefully monitored for acute adrenal insufficiency in response to stress. In those patients who have asthma or other clinical conditions requiring long-term systemic corticosteroid treatment, too rapid a decrease in systemic corticosteroids may cause a severe exacerbation of their symptoms.

The concomitant use of intranasal corticosteroids with other inhaled corticosteroids could increase the risk of signs or symptoms of hypercorticism and/or suppression of the hypothalamic-pituitary-adrenal (HPA) axis.

Persons who are using drugs that suppress the immune system are more susceptible to infections than healthy individuals. Chickenpox and measles, for example, can have a more serious or even fatal course in susceptible children or adults using corticosteroids. In children or adults who have not had these diseases or been properly immunized, particular care should be taken to avoid exposure. How the dose, route, and duration of corticosteroid administration affect the risk of developing a disseminated infection is not known. The contribution of the underlying disease and/or prior corticosteroid treatment to the risk is also not known. If exposed to chickenpox, prophylaxis with varicella zoster immune globulin (VZIG) may be indicated. If exposed to measles, prophylaxis with pooled intramuscular immunoglobulin (IG) may be indicated. (See the respective package inserts for complete VZIG and IG prescribing information.) If chickenpox develops, treatment with antiviral agents may be considered.

Avoid spraying in eyes.

PRECAUTIONS

General: Intranasal corticosteroids may cause a reduction in growth velocity when administered to pediatric patients (see PRECAUTIONS: Pediatric Use).

Rarely, immediate hypersensitivity reactions or contact dermatitis may occur after the administration of FLONASE Nasal Spray. Rare instances of wheezing, nasal septum perforation, cataracts, glaucoma, and increased intraocular pressure have been reported following the intranasal application of corticosteroids, including fluticasone propionate.

Use of excessive doses of corticosteroids may lead to signs or symptoms of hypercorticism and/or suppression of HPA function.

Although systemic effects have been minimal with recommended doses of FLONASE Nasal Spray, potential risk increases with larger doses. Therefore, larger than recommended doses of FLONASE Nasal Spray should be avoided.

When used at higher than recommended doses or in rare individuals at recommended doses, systemic corticosteroid effects such as hypercorticism and adrenal suppression may appear. If such changes occur, the dosage of FLONASE Nasal Spray should be discontinued slowly consistent with accepted procedures for discontinuing oral corticosteroid therapy.

In clinical studies with fluticasone propionate administered intranasally, the development of localized infections of the nose and pharynx with *Candida albicans* has occurred only rarely. When such an infection develops, it may require treatment with appropriate local therapy and discontinuation of treatment with FLONASE Nasal Spray. Patients using FLONASE Nasal Spray over several months or longer should be examined periodically for evidence of *Candida* infection or other signs of adverse effects on the nasal mucosa.

Intranasal corticosteroids should be used with caution, if at all, in patients with active or quiescent tuberculous infections of the respiratory tract; untreated local or systemic fungal or bacterial infections; systemic viral or parasitic infections; or ocular herpes simplex.

Because of the inhibitory effect of corticosteroids on wound healing, patients who have experienced recent nasal septal ulcers, nasal surgery, or nasal trauma should not use a nasal corticosteroid until healing has occurred.

Information for Patients: Patients being treated with FLONASE Nasal Spray should receive the following information and instructions. This information is intended to aid them in the safe and effective use of this medication. It is not a disclosure of all possible adverse or intended effects.

Patients should be warned to avoid exposure to chickenpox or measles and, if exposed, to consult their physician without delay.

Patients should use FLONASE Nasal Spray at regular intervals for optimal effect. Some patients (12 years of age and older) with seasonal allergic rhinitis may find as-needed use of 200 mcg once daily effective for symptom control (see Clinical Trials section of full prescribing information).

A decrease in nasal symptoms may occur as soon as 12 hours after starting therapy with FLONASE Nasal Spray. Results in several clinical trials indicate statistically significant improvement within the first day or two of treatment; however, the full benefit of FLONASE Nasal Spray may not be achieved until treatment has been administered for several days. The patient should not increase the prescribed dosage but should contact the physician if symptoms do not improve or if the condition worsens.

For the proper use of FLONASE Nasal Spray and to attain maximum improvement, the patient should read and follow carefully the patient's instructions accompanying the product.

Drug Interactions: In a placebo-controlled, crossover study in 8 healthy volunteers, coadministration of a single dose of orally inhaled fluticasone propionate (1,000 mcg; 5 times the maximum daily intranasal dose) with multiple doses of ketoconazole (200 mg) to steady state resulted in increased mean fluticasone propionate concentrations, a reduction in plasma cortisol AUC, and no effect on urinary excretion of cortisol. This interaction may be due to an inhibition of cytochrome P450 3A4 by ketoconazole, which is also the route of metabolism of fluticasone propionate. No drug interaction studies have been conducted with FLONASE Nasal Spray, however, care should be exercised when fluticasone propionate is coadministered with long-term ketoconazole and other known cytochrome P450 3A4 inhibitors.

Carcinogenesis, Mutagenesis, Impairment of Fertility: Fluticasone propionate demonstrated no tumorigenic potential in mice at oral doses up to 1,000 mcg/kg (approximately 20 times the maximum recommended daily intranasal dose in adults and approximately 10 times the maximum recommended daily intranasal dose in children on a mcg/m² basis) for 78 weeks or in rats at inhalation doses up to 57 mcg/kg (approximately 2 times the maximum recommended daily intranasal dose in adults and approximately equivalent to the maximum recommended daily intranasal dose in children on a mcg/m² basis) for 104 weeks.

Fluticasone propionate did not induce gene mutation in prokaryotic or eukaryotic cells in vitro. No significant clastogenic effect was seen in cultured human peripheral lymphocytes in vitro or in the mouse micronucleus test.

No evidence of impairment of fertility was observed in reproductive studies conducted in male and female rats at subcutaneous doses up to 50 mcg/kg (approximately 2 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis). Prostate weight was significantly reduced at a subcutaneous dose of 50 mcg/kg.

Pregnancy: *Teratogenic Effects:* Pregnancy Category C. Subcutaneous studies in the mouse and rat at 45 and 100 mcg/kg, respectively (approximately equivalent to and 4 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis, respectively) revealed fetal toxicity characteristic of potent corticosteroid compounds, including embryonic growth retardation, omphalocele, cleft palate, and retarded cranial ossification.

In the rabbit, fetal weight reduction and cleft palate were observed at a subcutaneous dose of 4 mcg/kg (less than the maximum recommended daily intranasal dose in adults on a mcg/m² basis).

However, no teratogenic effects were reported at oral doses up to 300 mcg/kg (approximately 25 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis) of fluticasone propionate to the rabbit. No fluticasone propionate was detected in the plasma in this study, consistent with the established low bioavailability following oral administration (see CLINICAL PHARMACOLOGY section of full prescribing information).

Fluticasone propionate crossed the placenta following oral administration of 100 mcg/kg to rats or 300 mcg/kg to rabbits (approximately 4 and 25 times, respectively, the maximum recommended daily intranasal dose in adults on a mcg/m² basis).

There are no adequate and well-controlled studies in pregnant women. Fluticasone propionate should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

Experience with oral corticosteroids since their introduction in pharmacologic, as opposed to physiologic, doses suggests that rodents are more prone to teratogenic effects from corticosteroids than humans. In addition, because there is a natural increase in corticosteroid production during pregnancy, most women will require a lower exogenous corticosteroid dose and many will not need corticosteroid treatment during pregnancy.

Nursing Mothers: It is not known whether fluticasone propionate is excreted in human breast milk. However, other corticosteroids have been detected in human milk. Subcutaneous administration to lactating rats of 10 mcg/kg of tritiated fluticasone propionate (less than the maximum recommended daily intranasal dose in adults on a mcg/m² basis) resulted in measurable radioactivity in the milk. Since there are no data from controlled trials on the use of intranasal fluticasone propionate by nursing mothers, caution should be exercised when FLONASE Nasal Spray is administered to a nursing woman.

Pediatric Use: Five hundred (500) patients aged 4 to 11 years and 440 patients aged 12 to 17 years were studied in US clinical trials with fluticasone propionate nasal spray. The safety and effectiveness of FLONASE Nasal Spray in children below 4 years of age have not been established.

Controlled clinical studies have shown that intranasal corticosteroids may cause a reduction in growth velocity in pediatric patients. This effect has been observed in the absence of laboratory evidence of HPA axis suppression, suggesting that growth velocity is a more sensitive indicator of systemic corticosteroid exposure in pediatric patients than some commonly used tests of HPA axis function. The long-term effects of this reduction in growth velocity associated with intranasal corticosteroids, including the impact on final adult height, are unknown. The potential for "catch-up" growth following discontinuation of treatment with intranasal corticosteroids has not been adequately studied. The growth of pediatric patients receiving intranasal corticosteriods, including FLONASE Nasal Spray, should be monitored routinely (e.g., via stadiometry). The potential growth effects of prolonged treatment should be weighed against the clinical benefits obtained and the risks/benefits of treatment alternatives. To minimize the systemic effects of intranasal corticosteroids, including FLONASE Nasal Spray, each patient should be titrated to the lowest dose that effectively controls his/her symptoms.

Geriatric Use: A limited number of patients 65 years of age and older (n =129) or 75 years of age and older (n=11) have been treated with FLONASE Nasal Spray in US and non-US clinical trials. While the number of patients is too small to permit separate analysis of efficacy and safety, the adverse reactions reported in this population were similar to those reported by younger patients.

ADVERSE REACTIONS

In controlled US studies, more than 3,300 patients with seasonal allergic, perennial allergic, or perennial nonallergic rhinitis received treatment with intranasal fluticasone propionate. In general, adverse reactions in clinical studies have been primarily associated with irritation of the nasal mucous membranes, and the adverse reactions were reported with approximately the same frequency by patients treated with the vehicle itself. The complaints did not usually interfere with treatment. Less than 2% of patients in clinical trials discontinued because of adverse events; this rate was similar for vehicle placebo and active comparators.

Systemic corticosteroid side effects were not reported during controlled clinical studies up to 6 months' duration with FLONASE Nasal Spray. If recommended doses are exceeded, however, or if individuals are particularly sensitive or taking FLONASE Nasal Spray in conjunction with administration of other corticosteroids, symptoms of hypercorticism, e.g., Cushing syndrome, could occur.

The following incidence of common adverse reactions (>3%, where incidence in fluticasone propionate-treated subjects exceeded placebo) is based upon 7 controlled clinical trials in which 536 patients (57 girls and 108 boys aged 4 to 11 years, 137 female and 234 male adolescents and adults) were treated with FLONASE Nasal Spray 200 mcg once daily over 2 to 4 weeks and 2 controlled clinical trials in which 246 patients (119 female and 127 male adolescents and adults) were treated with FLONASE Nasal Spray 200 mcg once daily over 6 months. Also included in the table are adverse events from 2 studies in which 167 children (45 girls and 122 boys aged 4 to 11 years) were treated with FLONASE Nasal Spray 100 mcg once daily for 2 to 4 weeks.

Overall Adverse Experiences With >3% Incidence on Fluticasone Propionate in Controlled Clinical Trials With FLONASE Nasal Spray in Patients ≥4 Years With Seasonal or Perennial Allergic Rhinitis

Adverse Experience	Vehicle Placebo Daily (n=758) %	FLONASE 100 mcg Once Daily (n=167) %	FLONASE 200 mcg Once (n=782) %
Headache	14.6	6.6	16.1
Pharyngitis	7.2	6.0	7.8
Epistaxis	5.4	6.0	6.9
Nasal burning/ nasal irritation	2.6	2.4	3.2
Nausea/vomiting	2.0	4.8	2.6
Asthma symptoms	2.9	7.2	3.3
Cough	2.8	3.6	3.8

Other adverse events that occurred in ≤3% but ≥1% of patients and that were more common with fluticasone propionate (with uncertain relationship to treatment) included: blood in nasal mucus, runny nose, abdominal pain, diarrhea, fever, flu-like symptoms, aches and pains, dizziness, bronchitis.

Observed During Clinical Practice: In addition to adverse events reported from clinical trials, the following events have been identified during postapproval use of fluticasone propionate in clinical practice. Because they are reported voluntarily from a population of unknown size, estimates of frequency cannot be made. These events have been chosen for inclusion due to either their seriousness, frequency of reporting, or causal connection to fluticasone propionate or a combination of these factors.

General: Hypersensitivity reactions, including angioedema, skin rash, edema of the face and tongue, pruritus, urticaria, bronchospasm, wheezing, dyspnea, and anaphylaxis/anaphylactoid reactions, which in rare instances were severe.

Ear, Nose, and Throat: Alteration or loss of sense of taste and/or smell and, rarely, nasal septal perforation, nasal ulcer, sore throat, throat irritation and dryness, cough, hoarseness, and voice changes.

Eye: Dryness and irritation, conjunctivitis, blurred vision, glaucoma, increased intraocular pressure, and cataracts.

Cases of growth suppression have been reported for intranasal corticosteroids, including FLONASE (see PRECAUTIONS: Pediatric Use).

OVERDOSAGE

Chronic overdosage may result in signs/symptoms of hypercorticism (see PRECAUTIONS). Intranasal administration of 2 mg (10 times the recommended dose) of fluticasone propionate twice daily for 7 days to healthy human volunteers was well tolerated. Single oral doses up to 16 mg have been studied in human volunteers with no acute toxic effects reported. Repeat oral doses up to 80 mg daily for 10 days in volunteers and repeat oral doses up to 10 mg daily for 14 days in patients were well tolerated. Adverse reactions were of mild or moderate severity, and incidences were similar in active and placebo treatment groups. Acute overdosage with this dosage form is unlikely since 1 bottle of FLONASE Nasal Spray contains approximately 8 mg of fluticasone propionate.

The oral and subcutaneous median lethal doses in mice and rats were >1,000 mg/kg (>20,000 and >41,000 times, respectively, the maximum recommended daily intranasal dose in adults and >10,000 and >20,000 times, respectively, the maximum recommended daily intranasal dose in children on a mg/m² basis).

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SUGAR AND SPICE: In Bahia, Brazil, photographer David de Souza posed dancers in a nearby sugarcane field to invoke the origins of *capoeira*—the word roughly means "cleared field" in Tupí-Guaraní, a local language. It was originally a deadly sport of Angolan slaves (brought to Brazil by the Portuguese 400 years ago), who executed rapid parries and somersaults with sharpened blades strapped to their ankles. These days, minus the cutlery, it's a popular dance/martial art of quick and graceful movements that is rapidly growing in popularity around the world.

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The Cheech Marin Collection

AROUND THE MALL

BACK WHEN HE WAS IN ELEMENTARY SCHOOL in the 1950s, Cheech Marin was a regular at his hometown public library in Granada Hills, a Los Angeles suburb. "Every art book and portfolio they had, I lugged them all home," says Marin, 56, who would grow up to become an actor, comedian and director. "I memorized all the images—Cézanne, Manet, Picasso, Pissarro." Not even the teacher who told him he would never make it as a painter could undermine his growing enthusiasm.

Not long after he got his first break in show business—Marin and his partner in comedy, Tommy Chong, were discovered by a record executive at Los Angeles' Troubador Club in 1970—he began to collect art. Marin (who made eight films with Chong, among them *Up In Smoke*, 1978, and *After Hours*, 1985; and starred for six seasons—until 2001—with Don Johnson in the CBS series *Nash Bridges*) concentrated on artists from his own Mexican-American heritage. Now, Marin's acquisitions form the nucleus of "Chicano Visions: American Painters on the Verge," the first of a two-part exhibition that opened this May at the Smithsonian's Arts and Industries Building in Washington, D.C. Fifty-two of the 73

Patssi Valdez's *Room on the Verge*, which Marin bought in 1993, plays on the idea of a home not so sweet.

Marin had a six-season run as Don Johnson's sidekick in TV's high-drama *Nash Bridges*.

works on display are from Marin's collection. Some two dozen will remain at the museum through January 5 in "Chicano Now: American Expressions."

"These painters," Marin says, touring the show, "capture what it means to be an American and, simultaneously, an outsider." Many of them, he adds, are "rooted in the Mexican cultural past, yet are jammed against American pop culture."

The images range from realistic riffs on life and death in L.A. (Carlos Almaraz's *Sunset Crash*, a depiction of cars plunging off a freeway overpass) to the kinetic allure of Patssi Valdez's *Room on the Verge*, her depiction of a surreal interior space—a dining room in the vortex of a tornado—in which table, chairs, plates and cutlery swirl in midair. "This painting reminds me of works by Matisse, there's that kind of magic residing here," Marin says of the canvas that lent its name to the exhibition. "My intention is to introduce to a larger audience these world-class artists—painters who can stand on the stage with anyone."

—Frank B. Phillippi

End of an Era

Miss Manners would have been appalled. After all, the invitations came by e-mail, refreshments were nowhere to be found and a sign on the entrance door announced "No soldering, cutting or burning." The promised "Open House" might more accurately have been described as "Moving Out!" Nonetheless, the modest event in the richly appointed library space, known as the Jewett Room, of the Arts and Industries Building, offered compensations for the lack of entertaining etiquette.

Here was a chance for staffers to bid farewell to the home of some 5,000 rare books on natural history. Dating to 1881, the room housed in grand 19th-century tradition the archives for the original Smithsonian museum.

The open house afforded one final chance to peek through glass-covered cabinets—39 in all—that hug the perimeters of the main floor and the dainty mezzanine overhead, and to contemplate some intriguing if curious titles: *Upland Game Bird Shooting in America. Field and Forest Rambles. Ladies' Flower Garden of Ornamental Bulbous Plants*. The gathering also provided opportunity to climb the narrow, winding stairs to the upper level and aim a point-and-shoot camera at the intimate library space below, which is just what the Natural History Museum's marine biologist Jim Mead was doing. "I have always been fond of this place," he said. "Libraries in that format—they have a pleasant ambience, one that is fast disappearing." The books would soon be packed up and moved across the Mall to the National Museum of Natural History and its state-of-the-art high security, temperature-and-humidity-controlled storage room of the new Joseph F. Cullman, 3rd, Library of Natural History, opening to scholars this month. Sadly, there will be no browsing privileges.

Dating to 1881, the Smithsonian's first archives closed its doors in July.

So, just to hang out with the affable Leslie Overstreet, curator of rare books, and to inquire, as a few of Mead's interns did, about her particular favorites, brought a bittersweet quality to the occasion. Leafing through a a 1587 German herbal, Overstreet confessed a particular fondness for its blind-stamped pigskin binding and hand-colored wood-block illustrations. One visitor asked about the raised bands on the book's spine that are common to this period and was told they house the cords on which the pages are sewn. Overstreet pointed out that the German vernacular in which the book was written indicated that it was intended for the practicing herbalist, perhaps the local apothecary, rather than a scholarly sort.

If it lacks some of the quirky charisma of the Jewett Room, the new Cullman Library nevertheless consolidates the Smithsonian's geographically dispersed rare natural history books. Several thousand additional volumes are squirreled away in the museum's departmental libraries. "They are stashed in various locked cabinets and cages all over the place," says Smithsonian Libraries director Nancy E. Gwinn of the diaspora. "The books have not resided, for the most

TOM WOLFF; SMITHSONIAN INSTITUTION ARCHIVES; P. 45 PATSSI VALDEZ/CHEECH MARIN COLLECTION

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Hurry In

"Modern Mongolia" closes at the National Museum of Natural History October 25. It will then move on to Middlebury College in Vermont (January 28 through April 26, 2003). The show's artifacts include these intricately hand-embroidered boots.

Visit the Smithsonian

For a free Associates' planning packet, call Smithsonian Information, 202-357-2700 or 202-357-1729 (TTY), 9 A.M.-5 P.M., Monday through Saturday, or send an e-mail to info@si.edu.

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Upon arrival, stop at the Smithsonian Information Center in the Castle (9 A.M.-5:30 P.M.). Most museums are open daily, 10 A.M.-5:30 P.M., except December 25. Members are invited to drop by the reception desk (9 A.M.-4 P.M.) to register for a behind-the-scenes tour and to hear about membership benefits.

part, in good environmental conditions." The consolidation brings a greater degree of convenience for researchers. "They had to run all over to look at various books," Gwinn says. "To pull all these books together in one space is a great boon."

So the days of burnished inconvenience—of wooden bookshelves, exposed beams and red-patterned carpet—are over. Good-bye to the winding staircase. To the mezzanine and its wooden railing. "There is a little nostalgia attached to the Jewett Room," Gwinn acknowledges. "It looks like what you would expect a venerable institution's library to look like. But the benefits far outweigh the nostalgia."

—Victoria Dawson

Air, Space and a Lot of Water

Lunchtime diners at Salty's, a popular seafood restaurant along Seattle's Elliott Bay waterfront, won't soon forget the day, this spring, that a Boeing S-307 Stratoliner, newly restored to its gleaming 1940s splendor, executed a wide turn in front of the eatery's floating deck and crashed into the water.

"I had just walked out of the dining room," says Tim O'Brien, Salty's beverage manager. "In the next second, I heard the sound 210 people make when they get up from lunch and start running for the doors. I heard no other noise at all. No splash. No whoosh. By the time I got outside, the plane had slid into the bay just in front of our restaurant. It was drifting slowly forward, kind of like a big, silver lily pad."

A water landing wasn't what the aircraft's pilot and flight crew had in mind, either. After six years of refurbishment, the four-engine plane, the only one extant of ten Stratoliners originally constructed as commercial airline prototypes, was being flight-checked for early delivery to the National Air and Space Museum's (NASM) Steven F. Udvar-Hazy Center, which opens next December at Washington Dulles International Airport.

The shakedown flight had begun with an uneventful, 12:30 P.M. departure from Boeing Field and a landing at Paine Field, about 25 miles to the north. After a smooth takeoff, the Stratoliner's Number 3 engine (on the inboard right) had a momentary surge, prompting pilot Richard Nelson and co-pilot Michael Carriker to plot an immediate course for return to Boeing Field.

But that idea had to be jettisoned when the Stratoliner's left landing gear refused to extend completely. Then the low-fuel-pressure signal light for Stratoliner's Number 3 engine came on. As crew members prepared to shut the Number 3 engine down, engines 4, 1 and 2 lost power in succession, leaving Nelson one option: ditching the aircraft in the shallows of Elliott Bay.

When NASM's Stratoliner crashed in Seattle's bay, no one was injured.

UNIVERSITY OF PENNSYLVANIA, MUSEUM OF ARCHAEOLOGY AND ANTHROPOLOGY; CHERYL HATCH/AP PHOTO

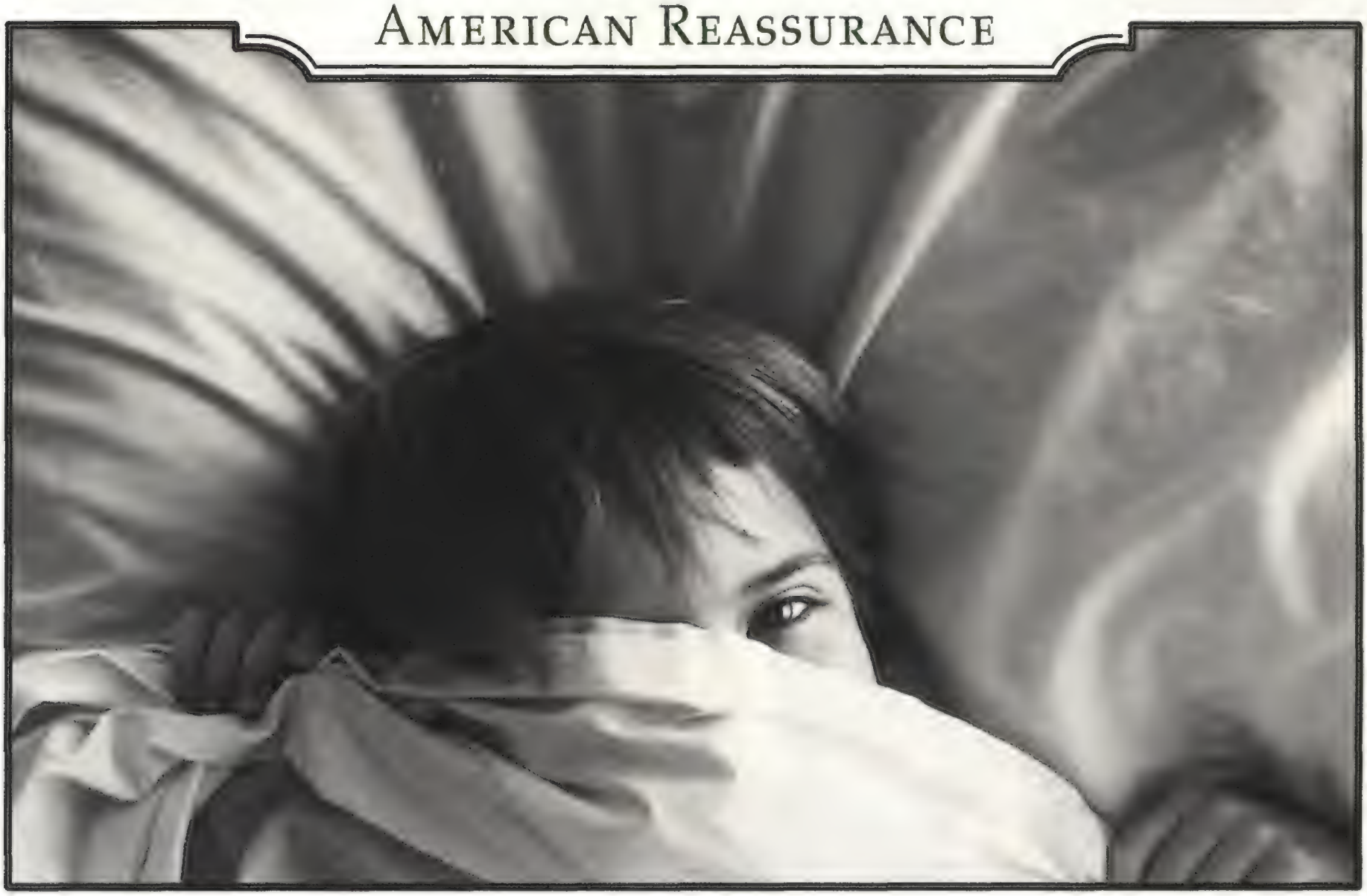
"The Stratoliner lifted up slightly just before it hit the water," recalls O'Brien, "then the pilot dropped her down ever so gently and precisely, which is amazing, because that Stratoliner's a big, big plane."

None of the four crewmen were hurt. Within two days, the aircraft had been lifted onto crane-operated cradles and hoisted out of the bay. So far, neither Boeing nor the Smithsonian Institution can cite an official cause for the crash; a National Transportation Safety Board review is under way.

"We have high hopes for a full and complete restoration," says NASM curator Ron Davies. "We still plan to make the Stratoliner a centerpiece at the new center. We'll get her back to gleaming glory once again."

—Donovan Webster

American Reassurance



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Learning from the Missile Crisis

What Really Happened on Those Thirteen Fateful Days in October

BY MAX FRANKEL

IT WAS A LOVELY AUTUMN DAY 40 YEARS AGO THIS MONTH, A DAY NOT UNLIKE SEPTEMBER 11, 2001, when Americans realized that the oceans no longer protected us from enemy attack. Those old enough that October 22, 1962 to know the name John F. Kennedy will never forget the fear that swept through homes and cities when the president appeared on television, grave and gray, to proclaim a crisis. Reading a stern ultimatum to the Russians that called them nuclear cheats and liars for placing offensive missiles in Cuba, he also left the impression that his counteractions might any minute provoke a rain of Soviet missiles. The news terrified the public for six days and nights (though less for those of us trained to parse the bellicose words and signals flying urgently between Moscow and Washington). And as Hollywood has demonstrated time and again, the drama of the Cuban missile crisis has the power to instruct, beguile and entertain Americans in every decade.

The 2000 film version, with Kevin Costner playing an absurdly fictionalized role as Kennedy's aide Kenneth O'Donnell, was called *Thirteen Days*, referring to the period of public alarm plus the period of frantic, secret debate that preceded it as Kennedy planned a response to the discovery of the nuclear rockets in Cuba. If the moviemakers had bothered with the Soviet and Cuban sides of the crisis, they could have made a vastly better film, reasonably called *Thirteen Weeks*. And had they examined the calamitous miscalculations on all sides, it might have been titled *Thirteen Months*.

Most accounts of the crisis concentrate only on the Washington players, led by the glamorous, nervous president and his shrewd younger brother, Robert. A view of Havana would feature the humbling of Fidel Castro, Cuba's bearded Robin Hood, and his scheming younger brother, Raúl. In Moscow a bombastic Nikita Khrushchev was drowning in sweat as his boldest Cold War maneuver collapsed into retreat. This is a tale about a fateful triangle.

"My fellow citizens," President Kennedy began 40 years ago, warning Americans of a "secret, swift and extraordinary build-up of Communist missiles" in Cuba. Kennedy considered his handling of the crisis his greatest achievement as president.

Like the attacks of 9/11, the missile crisis had deep political roots that were unwittingly nourished by our own conduct. Also like 9/11, our failure to imagine the threat beforehand caused us to ignore the few available warnings. Yet the 1962 showdown left us ill prepared for an Osama bin Laden, because our Soviet foes 40 years ago—though we demonized them as evil aggressors—were *rational* rivals who valued life. We played nuclear poker against them but shared a common interest in the casino's survival.

As a reporter in Washington I covered the Cuban drama for the *New York Times* and have studied it faithfully since. Over the years, our knowledge of it has been enhanced by autobiographies written by many participants, by a great deal of scholarship and by nostalgic, on-the-record gatherings of Soviet, American and Cuban officials. We also have had credible reports on the contents of Soviet files and, most recently, verbatim records of crisis deliberations in the Kennedy White House.

In hindsight, I think two common views need correction. It is clear now that Nikita Khrushchev provoked America not from a position of strength, as Kennedy first feared, but from a chronic sense of weakness and frustration. And it is also clear from the historical record that the two superpowers were never as close to nuclear war as they urgently insisted in public.

Calamitous Miscalculations

KHRUSHCHEV, THE SOVIET LEADER, WAS A GAMBLER WHO had expected great returns from his radical economic reforms, denunciation of Stalin, release of political prisoners and gradual engagement with the rest of the world. He had visited the United States preaching coexistence and vowing to compete peacefully. But he was under tremendous pressure. The Soviet hold on Eastern Europe, a vital zone of defense against hated Germany, remained tenuous; Khrushchev's generals were clamoring for more expensive weaponry; his people were rioting to protest food shortages; and China's Chairman Mao was openly condemning Khrushchev for undermining Communist doctrine and betraying revolutionaries everywhere.

After the launch of *Sputnik* in 1957 revealed the sophistication of Soviet rockets, Khrushchev acquired the habit of rattling them at his most stubborn problems. Thanks to his missiles, which cost far less than conventional forces, he was hoping to shift money from military budgets into the USSR's backward food and consumer industries. By aiming medium-range missiles at West Germany, France and Britain, he hoped to force NATO to acknowledge Soviet domination over Eastern Europe. Toward that end, he kept threatening to declare Germany permanently divided and to expel Western garrisons from Berlin, which lay vulnerable in Communist East Germany. By also rattling long-range missiles at the United States, Khrushchev expected finally to be dealt with as an equal superpower.

Although President Eisenhower had not directly challenged the Soviets' sway over Eastern Europe, he had not yielded to any of Khrushchev's other ambitions. A new and inexperienced President Kennedy, therefore, struck the Soviet leader as a brighter prospect for intimidation.

Kennedy had arrived at the White House in early 1961 visibly alarmed by Khrushchev's newest bluster, a promise to give aid and comfort—though not Soviet soldiers—to support "wars of national liberation" in Asia, Africa and Latin America. Then, in April of that year, Kennedy stumbled into the fiasco of Cuba's Bay of Pigs, the humiliating failure of a CIA-sponsored invasion aimed at overthrowing Fidel Castro. So when Kennedy and the Soviet leader met in Vienna in June 1961, Khrushchev pummeled the American leader with threats to end Western occupation rights in Berlin and then watched with satisfaction when the president acquiesced in the building of the Berlin Wall.

Kennedy's response to Khrushchev's taunts was to flex his own missile muscle. During his presidential campaign he had criticized Republicans for tolerating a "missile gap" in Khrushchev's favor. Now he abandoned that pretense. As both governments knew, the Russians held only 20 or 30 intercontinental missiles, of unreliable design, and were having trouble building more. By contrast, the United States' missile, bomber and submarine forces could strike 15 times as many Soviet targets. The Kennedy team began to boast not only of this advantage but also to hint that it might, in a crunch, resort to a "first use" of nuclear weapons, leaving Russia unable to strike American targets.

Thus stung in the spring of 1962, Khrushchev came up with a bold idea: plant medium-range missiles in Cuba and thereby put most of the United States under the nuclear

NIKITA KHRUSHCHEV

In the spring of 1962, the Soviet leader wagered that a bold plan to ship nuclear weapons to Cuba would solve a host of problems at home and abroad. But he didn't think such an action would lead to nuclear confrontation.

FIDEL CASTRO

Shrewd in exacting Soviet aid in return for his cooperation, the Cuban leader said the missiles would "serve both the salvation of the Cuban Revolution and . . . the socialist Camp."

BETTMANN/CORBIS; HULTON-DEUTSCH COLLECTION/CORBIS; P. 52 RALPH CRANE/TIMEPIX; P. 53 HULTON ARCHIVE/GETTY IMAGES

gun. Without having to wait a decade for long-range missiles that he could ill afford, the Soviet leader would give Americans a taste of real vulnerability, save money for other things and strengthen his negotiating position.

Marshal Rodion Malinovsky, the Soviet defense minister, embraced the idea and helped sell it to dubious Soviet colleagues. Khrushchev's old chum and American expert Anastas Mikoyan predicted an unpleasant reaction from Washington and a tough sell in Cuba. But Khrushchev thought he could hide the buildup from Kennedy until the missiles were mounted and armed; he hoped to reveal his new poker hand in November during visits to the United Nations and Havana.

The Castro brothers were desperate for Soviet weaponry to protect them from American invaders, but they didn't want sealed-off bases under alien control. To overcome their resistance, Khrushchev forgave Cuba's debts, promised more economic aid and insisted his missiles would help defend the island and support Castro's dream of inspiring other Latin revolutions.

Castro was not fooled. There were easier ways to deter an invasion; Soviet ground troops in Cuba could serve as a trip wire to bring Moscow into any conflict, or Cuba could be included in Soviet defense agreements. Castro knew he was being used, but agreed to the bases to show "solidarity," as he put it, with the Communist bloc and to win more aid for his people.

In Washington as in Moscow, domestic politics fueled the drive toward confrontation. Through the summer of 1962, the U.S. Navy had tracked a large flotilla of ships from Soviet ports to Cuba, while the CIA heard confusing reports about sightings of military equipment on the island. Heading into a close Congressional election, Republicans saw a chance to repay Kennedy for his past attacks on their Cuba policy by mocking his tolerance for a Soviet buildup just 90 miles from Florida. But the administration's intelligence teams detected only nonnuclear "defensive" weapons—MIG fighter planes, torpedo boats and surface-to-air missiles (SAMs), which had a range of only 25 miles. Having roundly misread each other, Khrushchev and Kennedy brought this diplomatic stew to a boil.

The president's chief adviser throughout was his younger brother Robert, whose day-by-day account of the events helped mythologize JFK.

The Making of a Crisis

HEARING THE REPUBLICAN ALARMS ABOUT MISSILES IN Cuba, Khrushchev sent his ambassador, Anatoly Dobrynin, to Robert Kennedy with assurances that the Soviets would do nothing provocative before the American election. And when RFK complained that the buildup in Cuba was bad enough, the ambassador insisted—in innocence, it would turn out—that his government would never give another nation control over offensive weapons.

To fend off the Republicans, the Kennedy brothers hurriedly produced a statement saying that if any nation's forces were to achieve a "significant offensive capability" in Cuba, it would raise the "gravest issues." In a deceptive riposte, Khrushchev responded that his long-range missiles were so good he had "no need" to send big weapons "to any other country, for instance Cuba." OK, then, Kennedy countered, if Cuba ever became "an offensive military base

JOHN McCONE

The CIA director warned the president in the summer of 1962 that the Russians had to be up to something in Cuba. Then he departed Washington for a month for a poorly timed honeymoon.

DEAN RUSK

The secretary of state saw himself as a voice of moderation. When Khrushchev ordered several of his ships home, Rusk said: "We're eyeball-to-eyeball, and I think the other fellow just blinked."

AP/WIDE WORLD PHOTOS; BILL BRIDGES/TIMEPIX; BETTMANN/CORBIS

of significant capacity for the Soviet Union," he would do "whatever must be done" to protect American security.

American analysts concluded that the president's strong warnings made it highly unlikely that the Soviets would install a missile base in Cuba. After all, they had never placed nuclear weapons outside their own territory, not even in Communist Europe.

That fixed American mind-set caused Kennedy to dismiss reports from spies in Cuba of missiles much larger than "defensive" antiaircraft SAMs. Then a dumb coincidence delayed photoreconnaissance. Because on September 9 the Chinese shot down a U-2 plane photographing their terrain, the White House ordered U-2 pilots over Cuba to steer clear of areas protected by SAM defenses.

Equally ill timed was the marriage of CIA chief John McCone, a Republican and former businessman who was the only Washington official to have reasoned his way into Khrushchev's mind. Before embarking on his honeymoon at the end of August, McCone had tried to persuade Kennedy that the SAMs in Cuba could have only one purpose: to prevent U-2 spy planes from observing Khrushchev's probable next step—the installation of medium-range missiles capable of striking American cities. McCone's absence meant his suspicions, and insights, were not heard in Washington for most of September.

Once McCone returned, he learned that an intelligence analyst had indeed spotted, in a photograph, suspicious bulldozer patterns in the terrain in western Cuba—patterns resembling the layout of missile bases in Russia. McCone insisted on more aggressive reconnaissance, and finally, on October 14, in the suspect area near San Cristóbal, U-2 cameras 13 miles up snapped remarkably clear pictures of medium-range missile transporters, erectors and launchpads. It was compelling evidence of imminent deployment of nuclear weapons capable of striking Washington, D.C., St. Louis, Dallas. Khrushchev, deeply committed to defying Kennedy's warnings, was, in fact, installing at least 24 medium-range ballistic missile launchers (MRBMs), plus 16 intermediate-range missiles (IRBMs) that could reach any point in the continental United States except the northwest corner.

Kennedy, in turn, was just as deeply committed to prohibiting such bases. Upon seeing the U-2 photographs the morning of October 16, he first envisioned an air strike to destroy the missiles before they became operational. His more sober second thought was to keep the news a tight secret until he could take counsel and sift his options. Gauntlets thrown, here began the historic "thirteen days."

The President's Men Convene

WHAT APPEARS IN RETROSPECT TO HAVE BEEN A QUICKLY devised and effective American plan of action was actually the product of chaotic, contentious debate among official and unofficial advisers. They functioned as a rump "executive committee of the National Security Council," soon jargonized as "ExComm," and often met without Kennedy, to free up the discussion.

The ranking ExCommers were the president and his brother, the attorney general; Dean Rusk, secretary of state; Robert McNamara, secretary of defense; McGeorge Bundy, national security adviser; Douglas Dillon, secretary of the treasury; Gen. Maxwell Taylor, chairman of the Joint Chiefs of Staff, and the other chiefs; John McCone of the CIA; and United Nations representative Adlai Stevenson. They all made a show of keeping their public schedules while moving in and out of secret meetings. From Tuesday, October 16, through Sunday, the 21st, they gulped sandwiches for lunch and dinner and kept their own notes in longhand, without secretaries. They shuttled among meeting sites by crowding circus-style into a few cars, to avoid a telltale herd of limousines. They lied to their wives, to subordinates and to the press. For the climactic hours of decision, the president cut short a campaign visit to Chicago, feigning a bad cold and a slight fever.

All this undemocratic secrecy served a policy purpose. The president was afraid that his options could be dangerously reduced if Khrushchev knew he had been found out. Kennedy worried that the Soviet leader might then stake out a preemptive threat to retaliate for any attack on his missiles, either by firing some of them or attacking American forces in Berlin or Turkey. Alerting Congress could have provoked demands for swift military action without allowing time to study the consequences.

The more the ExComm members talked, the less they agreed on a course of action. Every day brought more evidence of Soviet haste. Some of the missiles, the ExComm

ROBERT McNAMARA

The secretary of defense opposed Kennedy's initial plan to order an air strike against the bases. McNamara said the United States still held a huge strategic advantage over the Soviets.

McGEORGE BUNDY

At various times, the national security adviser favored all of the options on the table—air strike with warning, surprise attack, naval blockade, no action at all.

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members speculated, would surely be armed with nuclear warheads within days, and all within weeks.

So what? the president asked provocatively at one point. He had once said a missile was a missile, whether fired from 5,000 or 5 miles away. And Defense Secretary McNamara held throughout the discussion that 40 or 50 more missiles pointed at U.S. targets, while perhaps quadrupling the Soviets' strike capacity, did nothing to alter our huge strategic advantage. The Joint Chiefs disagreed, insisting that by dramatically increasing America's sense of vulnerability, the Soviet weapons would greatly limit our choices in any future exchange of threats or fire.

Everyone soon acknowledged that Soviet bases in Cuba were, at the very least, psychologically and politically intolerable. They would embolden Khrushchev's diplomacy, especially when it came to his designs in Berlin. They would also enhance Castro's prestige in Latin America and erode Kennedy's stature at home and abroad. As if the missiles themselves were not challenge enough, Khrushchev's deception was seen as undermining U.S.-Soviet negotiations.

The president kept posing the issue starkly, insisting there were only two ways to remove the missiles: bargain them out or bomb them out.

Bargaining might entail painful concessions in Berlin or the withdrawal of American missiles from NATO bases in Turkey; though the weapons were technically obsolete, they represented commitment to an ally. Bombing Cuba would surely kill Russians and risk Soviet counterattack against American bases in Florida or Europe. (Our southern coast lacked radar defenses; as General Taylor observed prophetically at the time, "We have everything, except [the capability] to deal with a simple aircraft coming in low.") In any case, a strike at Cuba was bound to miss some missiles and require a follow-up invasion to seize the island.

Small wonder the advisers changed opinions as often as they changed clothes. For every possible "if," they conjectured a discouraging "then." If we withdrew our missiles from Turkey, then the Turks would shout to the world that American guarantees are worthless. If we sent a Polaris missile submarine into Turkish waters to replace the missiles, the Turks would say we always slither out of harm's way.

What if we warn Khrushchev of a coming air strike? Then he'll commit to a violent response. And if we don't warn him? Then he'll suffer a surprise attack, seize the moral high ground and announce that the United States would rather risk world war than live with the vulnerability that all Europeans have long endured.

Round and round they went. What about a U.S. naval blockade of Soviet weapons coming into Cuba? Well, it would not remove missiles already in place or prevent deliveries by air. A total blockade? That would offend friendly ships but not hurt Cuba for months.

Time grew short. Many Soviet missiles were installed, and the scent of crisis was in the air. At the *New York Times,* we heard of canceled speeches by the Joint Chiefs and saw officials being summoned away from their own birthday parties. Lights at the Pentagon and State Department blazed at midnight. We clamored for enlightenment, and officials mumbled about trouble in Berlin. Kennedy heard us approaching and asked our bureau chief, James "Scotty" Reston, to call him before we printed anything.

Thursday, October 18, was the day for a double bluff when Soviet Foreign Minister Andrei Gromyko paid a scheduled visit to the White House. He sparred with the president over Berlin but held tightly to his written-out claim that only "defensive" weapons were going to Cuba. Though angry, Kennedy and Rusk pretended to be fooled.

The president had told ExComm earlier that morning that he discounted the threat of a nuclear attack from Cuba—"unless they're going to be using them from every place." He most feared nonnuclear retaliation in Europe, probably in Berlin. But as McNamara put it to the group, firm action was essential to preserve the president's credibility, to hold the alliance together, to tame Khrushchev for future diplomacy—and by no means least—to protect the administration in domestic American politics.

Most important, ExComm had the benefit of the considered views of Llewellyn "Tommy" Thompson, Jr., the just-returned ambassador to Moscow who knew Khrushchev better and longer than any Western diplomat. He thought the Soviet leader intended for his missiles to be discovered—to invigorate his campaign against the West. Thompson felt that Khrushchev might well respect a U.S. weapons blockade and was unlikely to risk a fight in faraway Cuba. While he might strike impetuously at Berlin, that was a gamble he had been reluctant to take for four years.

Returning Saturday from Chicago with his "cold," Kennedy seemed to buy Thompson's assessment. He was

MAXWELL TAYLOR

The chairman of the Joint Chiefs observed that sophisticated U.S. defenses lacked the capability to deal with a low-flying aircraft. An air strike, Taylor noted, would leave some missiles in Cuba intact.

ADLAI STEVENSON

The ambassador to the United Nations feared an attack on Cuba might justify a counterattack on U.S. bases in Turkey. But he aggressively defended the American position.

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ready to risk a Berlin crisis because, as he had told the ExComm, "if we do nothing, we're going to have the problem of Berlin anyway." A blockade would buy time. They could always ratchet up tougher action if Khrushchev didn't back down.

Kennedy was plainly haunted, however, by the Bay of Pigs and by his reputation for timidity. So he ended the week's deliberation by again cross-examining the Joint Chiefs. Would an air strike destroy all the missiles and bombers? Well, 90 percent. And would Russian troops be killed? Yes, for sure. And couldn't Khrushchev just send more missiles? Yes, we'd have to invade. And wouldn't invasion provoke countermoves in Europe?

The president decided to avoid violent measures for as long as possible. But he did not want to reveal the tactical reasons for preferring a blockade. He insisted his aides use "the Pearl Harbor explanation" for rejecting an air strike—that Americans do not engage in preemptive surprise attacks—a disingenuous rationale that Robert Kennedy piously planted in histories of the crisis.

Story of a Lifetime

WHEN I LEARNED FROM HIS BUTLER THAT THE WEST GERman ambassador was fast asleep before midnight Friday, I became certain that the agitation in Washington did not concern Berlin, and so my *Times* colleagues and I focused on Cuba. And if it was Cuba, given all the recent alarms, that had to mean the discovery of "offensive" missiles. On Sunday, October 21, as promised, Scotty Reston called the White House. When Kennedy came on the line, Scotty asked me to listen on an extension.

"So you know?" Kennedy asked Reston, as I recall it. "And do you know what I'm going to do about it?"

"No, sir, we don't," Reston answered, "except we know you promised to act, and we hear you've asked for television time tomorrow night."

"That's right. I'm going to order a blockade."

I was tasting a great story when Kennedy dropped the other shoe. If he lost the element of surprise, he went on, Khrushchev could take steps that would deepen the crisis. Would we suppress the news in the national interest?

Reston called a meeting. For reasons patriotic or selfish, I at first resisted granting the president's request. A blockade is an act of war. Did we have the right to suppress news of a superpower war before Congress or the public had even an inkling of danger?

Reston phoned the president again and explained our concern. Did Kennedy want secrecy until after the shooting had begun?

"Scotty," the president said, "we've taken a whole week to plan our response. I'm going to order a blockade. It's the least I can do. But we will not immediately attack. You have my word of honor: there will be no bloodshed before I explain this very serious situation to the American people."

Given the president's word of honor, I believe to this day that we were right to defer publication by 24 hours. Kennedy's reasons were persuasive: our disclosure could have led the Soviets to threaten a violent response against the blockade and thus provoke a violent conflict. But I took my name off the fudged story I wrote for Monday's paper: "Capital's Crisis Air Hints at Development on Cuba," which, without mentioning missiles or a blockade, said the president would deliver news of a crisis. Like the *Washington Post*, which had been similarly importuned by the president, we held back most of what we knew.

Kennedy's speech that Monday evening, October 22, was the most menacing of any presidential address during the entire Cold War. Although the senate leaders whom he had just briefed deplored his reluctance to attack, Kennedy stressed the danger implicit in the moment:

"[T]his secret, swift, and extraordinary build-up of Communist missiles . . . in violation of Soviet assurances, and in defiance of American and hemispheric policy . . . is a deliberately provocative and unjustified change in the status quo which cannot be accepted by this country if our courage and our commitments are ever to be trusted again by either friend or foe. . . . Should these offensive military preparations continue . . . further action will be justified. . . . It shall be the policy of this nation to regard any nuclear missile launched from Cuba against any nation in the Western Hemisphere as an attack by the Soviet Union on the United States, requiring a full retaliatory response upon the Soviet Union."

Americans certainly did not underrate the gravity of events; families drew close, planned emergency escapes, hoarded food, and hung on every news bulletin. Friendly

WALLY MCNAMEE/CORBIS; HOWARD SOCHUREK/TIMEPIX

ANDREI GROMYKO

After the Soviet foreign minister insisted the missiles were "by no means offensive," the president said "it was incredible to sit there and watch the lies coming out of his mouth."

"TOMMY" THOMPSON

The U.S. ambassador to the Soviet Union seemed to know what Khrushchev was thinking. Historians would say his read on the Kremlin was "triumphantly accurate."

governments supported the president, but many of their people feared his belligerence, and some marched in protest. In a private letter to Khrushchev, Kennedy vowed to stand firm in Berlin, warning him not to misjudge the "minimum" action the president had taken so far.

The Kremlin's response encouraged both ExComm and diplomatic observers. While denouncing America's "piracy" at sea and instructing Soviet agents abroad to fan the fear of war, the Kremlin obviously had no ready plan for counteraction. Berlin was calm; so were our bases in Turkey. Moscow's government-controlled press pretended that Kennedy had challenged little Cuba rather than the Soviet Union. Khrushchev assented at once when the U.N. Secretary General, U Thant, tried to broker a pause for negotiation, but Kennedy decided to balk. In fact, Washington prepared a blunt notice about how the United States planned to challenge Soviet ships and fire dummy depth charges to force submarines to surface at the blockade line.

More good news came on Wednesday, October 24. The president kept some of his nuclear bombers airborne for the Russians to notice. And suddenly word arrived that Khrushchev had ordered his most vulnerable Cuba-bound ships to stop or turn tail. Recalling a childhood game in his native Georgia, Dean Rusk remarked, "We're eyeball-to-eyeball, and I think the other fellow just blinked."

Washington also soon learned that the Soviets had instructed the Cubans not to fire antiaircraft guns except in self-defense, giving American reconnaissance unhindered access. Kennedy now stressed that he, too, wanted no shots fired. He also wanted the Pentagon generals eager to enforce the blockade (officially designated a "quarantine") to know that although it was a military action, it was intended only to communicate a political message.

Public tension, however, persisted Thursday because work on the missile sites continued. But Kennedy let a Soviet oil tanker pass through the blockade after it identified itself and its cargo. And Friday morning, October 26, a Soviet ship allowed Americans to inspect what they knew would be innocent cargo. At the prospect of negotiation, however, Kennedy still could not decide what price he was willing to pay for a Soviet withdrawal of the missiles. ExComm (and the press) debated removing the U.S. missiles in Turkey, but the Turks would not cooperate.

The most unsettling hours were the next 24, which brought a maddening mix of good and bad news that once again rattled nerves in both Washington and Moscow. Three separate unofficial sources reported a Soviet inclination to withdraw from Cuba if the United States promised publicly to prevent another invasion of the island. And Friday night, in a rambling, highly emotional private message that he had obviously composed without the help of his advisers, Khrushchev implored Kennedy "not now to pull on the ends of the rope in which you have tied the knot of war." He said his weapons in Cuba were always intended to be "defensive," and if Cuba's safety were guaranteed, "the necessity for the presence of our military specialists in Cuba would disappear."

"I think we'd have to do that because we weren't going to invade them anyway," Kennedy told ExComm. But early Saturday, Moscow broadcast a colder message asking as well for an American withdrawal from Turkey. The Turks publicly protested and urged American officials not to capitulate.

The Russians seemed to be upping the ante, and Kennedy feared that he would lose world support and sympathy if he held out against the reasonable-sounding proposal to trade off reciprocal missile bases. Then came the shocking news that an American U-2 pilot had been shot down over Cuba and killed, presumably by a Soviet SAM, and another U-2 was chased out of Soviet Siberia, where it had accidentally strayed. Were accidents and miscalculations propelling the United States and the Soviet Union toward war after all?

In another Kennedy-Reston conversation that night that I was invited to listen in on, the president expressed his greatest fear that diplomacy might not resolve the crisis after all. He said the reconnaissance simply had to continue, and if his planes were again molested, he might be forced to attack antiaircraft installations.

With the Pentagon pressing for just such an attack, the president made doubly sure that no one assumed he had already decided to strike. He told ExComm that unless more planes were shot down, he envisioned the slowest possible escalation of pressure on the Soviets—starting with a blockade of oil shipments to Cuba, then of other vital supplies—taking great care to avoid the nuclear conflagration that the American public so obviously feared.

JAMES RESTON

After getting assurances from the president that there would be no bloodshed, the *New York Times* columnist and Washington bureau chief agreed to JFK's entreaties to sit on the scoop of a lifetime.

ANATOLY DOBRYNIN

The Soviet ambassador to the United States was kept out of the loop about what his country was up to. Still, he played a key role by conveying a secret U.S. promise to Khrushchev.

CAREY WINFREY; BOB GOMEL/TIMEPIX

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Eventually, perhaps, he would take a Russian ship in tow. And if he had to shoot, he thought it was wiser to sink a ship than to attack the missile sites.

Plainly neither Kennedy nor Khrushchev was anywhere near risking anything like a nuclear shoot-out.

Still, without much hope for negotiations, Kennedy yielded to advice from several ExComm members that he accept Khrushchev's no-invasion bargain and ignore the bid for a missile swap in Turkey. The president signaled his readiness to guarantee that the United States would not attack Cuba if the missiles were withdrawn, but simultaneously sent his brother to tell Soviet Ambassador Dobrynin that the time for diplomacy was running out, that work on the missiles had to stop at once.

On November 5, Soviet freighters (the *Anosov*, above) began returning missiles to the USSR, after Khrushchev backed down.

In delivering this ultimatum, however, Robert Kennedy also offered Khrushchev a sweetener: an oral promise to withdraw the missiles from Turkey within a few months, provided that this part of the deal was not disclosed. Only a half dozen Americans knew of this promise, and they, as well as the Russians, kept the secret for more than a decade.

A Collective Sigh of Relief

THE SUN SHONE BRIGHT IN WASHINGTON SUNDAY MORNing, October 28, as Radio Moscow read out Khrushchev's response to Kennedy's offer. He said he had wanted only to protect the Cuban revolution, that work at the bases on the island had now stopped, and that he had issued orders to dismantle, crate and bring back "the weapons which you describe as offensive."

Castro, bypassed in all the negotiations, threw a fit and refused to admit U.N. inspectors sent to the island to verify the de-armament, forcing homebound Soviet ships to uncover their missile cargoes for aerial inspection at sea. For a month, Castro even refused to let the Russians pack up their "gift" to him of several old Ilyushin bombers, which Kennedy also wanted removed.

President Kennedy, sensing Khrushchev's discomfort in retreat, immediately warned his jubilant aides against gloating. He had now earned his spurs as a Cold Warrior and the political freedom to reach other deals with the Soviets, starting with a crisis "hot line," a ban on aboveground nuclear tests and a live-and-let-live calm in Berlin. Thirteen months later he would be killed in Dallas—by a psychotic admirer of Fidel Castro.

Khrushchev emerged from the crisis with grudging respect for Kennedy and tried to share in the credit for moving toward a better relationship. But his generals and fellow oligarchs vowed never again to suffer such humiliation. Two years later, denouncing Khrushchev's many "harebrained schemes," they overthrew him, going on to spend themselves poor to achieve strategic weapons parity with the United States.

The Soviet Union and the United States never again stumbled into a comparable confrontation. Both nations acquired many more nuclear weapons than they would ever need, but they kept in close touch and learned to watch each other from orbiting satellites, to guard against surprise and miscalculation.

Condemned to Repeat?

THE CUBAN CRISIS HAD PROFOUND HISTORICAL IMPLICAtions. The arms race burdened both superpowers and contributed to the eventual implosion of the Soviet empire. Other nations reached for the diplomatic prowess that nuclear weapons seemed to confer. And the ExCommers wrongly assumed that they could again use escalating military pressure to pursue a negotiated deal—in Vietnam. They failed because none of them could read Ho Chi Minh the way Tommy Thompson had read Khrushchev.

The philosopher George Santayana was obviously right to warn that "those who cannot remember the past are condemned to repeat it." This past, however, acquired a rational, ordered form in our memories that ill prepared us for new and incoherent dangers. In our moments of greatest vulnerability—40 years ago and again last year—it was our inability to imagine the future that condemned us to suffer the shock of it.

MAX FRANKEL

The Pulitzer Prize-winning Max Frankel has written for the *New York Times* for more than 50 years and served from 1986 to 1994 as the paper's executive editor.

BETTMANN/CORBIS; THE NEW YORK TIMES

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SCIENTISTS ARE DISCOVERING THAT CAVES—MORE COMPLEX THAN WE EVER IMAGINED—MAY YIELD DEEP SECRETS ABOUT THE ORIGINS OF LIFE

Subterranean SURPRISES

BY EVAN HADINGHAM

PHOTOGRAPHS BY KEVIN DOWNEY

A FEW MILES SOUTH OF LOVELL, WYOMING, NEAR THE Montana border, the Burlington Northern railroad begins a gradual climb out of pastures and cottonwood groves. The track rises into a honey-colored gorge cut through Madison limestone, a formation already ancient by the time dinosaurs roamed Wyoming's seashores, then passes above an underground chamber, 30 feet below, known as Lower Kane Cave. The cave entrance is nearly invisible, a crack almost buried by the steeply piled rubble of the railway embankment.

Stumbling down this ankle-twisting slope behind a team of scientists, I squirmed feetfirst through the 30-inch crack. Bent double and fumbling my way forward in the gloom, I slipped into a fast-moving stream and floundered on all fours before finding enough room to stand upright on the mud bank. My eyes soon adjusted to the dim glow of my headlamp, but my skin remained sticky; unlike most caves at this latitude that stay pleasantly cool year-round, the temperature in Lower Kane hovers at an uncomfortably humid 75 degrees. An acrid, rotten smell stuck in my throat.

Scientist Annette Summers Engel squeezes into the 30-inch opening to Lower Kane Cave. Although most of the cave was carved by sulfuric acid, the entrance (left) was scalloped by the action of water and carbonic acid.

Lower Kane has none of the

Teeming colonies of microbes turn Lower Kane's pools into pop art paintings (top); scientists believe the bacteria (above) may hold clues to the origins of life itself.

these so-called active sulfide caves have been found worldwide. When first proposed in the early 1970s, the theory of their origins was so controversial that the scientific community took nearly two decades to embrace it. Eventually, the unusual geochemistry of these caves overturned conventional thinking about how they were formed.

More significantly, the discovery of "dark life"—teeming colonies of microbes thriving in these acid-drenched, pitch-black netherworlds—has thrown out a long-held belief that caves are mostly barren and sterile places. Scientists are hunting in these once-hidden depths for microbes that may lead to new cancer treatments. And cave research is also affecting scientists' thinking about the origins of life on earth and its possible existence on other worlds. "A cave is such a different environment, it's almost like going to another planet," says New Mexico Tech geomicrobiologist Penny Boston. "In a sense, it *is* another planet—the part of our own planet that we haven't explored yet. Just as the deep oceans became accessible to science only in the past few decades, now we're finding that kind of pioneering effort going on in caves." (A television exploration of cave research, "Mysterious Life of Caves," airs on PBS's *NOVA* October 1.)

IN THE LATE '60S, A STANFORD UNIVERSITY graduate student searching for a challenging topic for his PhD thesis became the first scientist to squeeze through the crack in the Wyoming railway embankment. Stephen Egemeier's curiosity was immediately aroused by Lower Kane's unusually warm temperatures and unpleasant smells. Even stranger were the huge, muddy heaps of a crumbly white mineral rarely found in caves. This was gypsum, or calcium sulfate, the main ingredient in Sheetrock or drywall, the material familiar from house construction. When Egemeier discovered that Lower Kane's springs were

sparkling columns or limestone "draperies" of subterranean tourist spots such as New Mexico's Carlsbad Caverns or Kentucky's Mammoth Cave. Scarcely larger than a typical New York City subway station, Lower Kane lacks even the humblest stalactite. Yet this unprepossessing cave is proving to be a scientific gold mine, drawing to its humid depths an energetic group of researchers, led by Annette Summers Engel of the University of Texas. Wearing safety masks to guard against toxic gases that bubble up from three spring-fed pools, the team is pursuing the latest chapter in a 30-year effort to understand the rare and exotic form of cave that Kane represents; only about a dozen of

not only hot but were bubbling hydrogen sulfide gas (notorious for its rotten-egg smell), he theorized that hydrogen sulfide was actively at work in carving out Lower Kane. Whatever underground source the potentially toxic gas ultimately came from—whether the volcanic reservoirs of Yellowstone to the west or the oil fields of the Bighorn Basin to the south—it was bubbling out of the springwater and into the cave. Naturally unstable, it was reacting with oxygen in the water to form sulfuric acid. The acid was eating away at the cave walls and producing gypsum as a by-product.

Egemeier's pioneering research was never widely published and attracted little attention in the '70s. But while it languished, another group of scientists was grappling with some equally puzzling cave riddles. This time, the scientific detective hunt unfolded far from Wyoming's rugged canyons in the well-trampled depths of a major tourist destination, Carlsbad Caverns.

THE EARLY CARLSBAD STORY IS ESSENtially the story of a single individual, Jim White. As a teenager in the 1890s, White was wandering near his campsite in the Guadalupe Mountains of southeastern New Mexico when he spotted a strange dark cloud swirling up from the desert floor. "I thought it was a volcano," he said later, "but then I'd never seen a volcano." Tracing the cloud to its origin at the mouth of a gigantic cavern, White stood transfixed by the spectacle of millions of bats pouring out on their nightly hunting exodus. So began his lifelong obsession with Carlsbad Caverns, which he generally explored alone, with only the feeble flicker of a kerosene lamp to guide him. White's tales of a vast underground labyrinth made him something of a local laughingstock until he persuaded a photographer to accompany him into the cave in 1915. In the months that followed, White would lower visitors in an iron bucket on a wobbly winch into the darkness 170 feet below. Today, of course, his solitary obsession has become a national park drawing half a million visitors a year.

But perhaps the most surprising aspect of the Carlsbad story is that even as late as the 1970s, when daily summer visitors numbered in the thousands, the caverns' mineralogy and its many puzzling features had hardly been studied. Speleology, or the study of caves, was barely a respectable science, and according to cave expert Carol Hill, mainstream geologists tended to dismiss as "grubby cavers" those who were attracted to the subject.

Lower Kane Cave lies in a limestone canyon beside the Bighorn River in Wyoming.

Then, one day in October 1971, Hill and three other young geology graduate students climbed a steep ladder into one of Carlsbad's remote chambers. As they clambered about the Mystery Room, named for the strange noise made by wind there, they were baffled by patches of bluish clay at their feet and crumbly, cornflake-like crusts on the walls. Odder still were the massive blocks of a soft, white mineral elsewhere in the cave. Such blocks shouldn't have been there at all.

For one thing, this mineral, gypsum, quickly dissolves in water. And the conventional explanation of how caves are formed involves the action of water—lots of it—percolating through limestone over millions of years. The chemistry is simple: as rain falls through the atmosphere and trickles into the soil, it picks up carbon dioxide and forms a weak acidic solution, carbonic acid. This mildly corrosive groundwater eats away the limestone and, over eons, etches out a cave.

According to this universally accepted theory, all limestone caves should consist of long, narrow corridors. Yet as anyone who has trekked through Carlsbad's main attraction, the Big Room, knows, it is a gigantic, cathedral-like hall extending over the equivalent of six football fields. Had a major underground river carved out this immense cavern, it should have eroded or swept aside everything in its path, including gypsum. Yet giant white heaps of the stuff up to 15 feet thick lie on the floor of the Big Room, one of the largest cave spaces in the world.

Puzzled, Hill was forced to conclude that some drastically different method of cave formation must have been at work in the Guadalupe Mountains. Soon she came up with a theory similar to Egemeier's: that hydrogen sulfide given off by nearby oil and gas fields had risen up through the mountains and reacted with oxygen in groundwater to produce sulfuric acid, which had then eaten away the caves over millions of years.

Her hydrogen sulfide theory aroused intense skepticism among geologists, who sought proof, which Carlsbad, as a "dead" or no longer forming cavern,

The theory of how sulfide caves like Lower Kane were formed was so radical that the scientific community resisted it for nearly two decades. Studying the cave is difficult. Scientists must wear protective gear to shield themselves from toxic gases.

could not provide. To confirm Hill's theory, scientists needed to investigate a site where sulfuric acid was still eating away at the cave—as it was at Lower Kane. But over the years the little cave under the railway track had been more or less forgotten.

In 1987, Hill's meticulous study of the Guadalupes at last appeared, coinciding with the publication of Stephen Egemeier's work after his death in 1985. These studies, along with new discoveries of a handful of other active sulfide caves around the world, proved beyond any doubt that caves in some regions were formed by sulfuric acid. But now a more tantalizing question arose: How could life thrive inside pitch-dark caverns full of toxic gas?

ONE OF MY SPOOKIEST MOMENTS VISITing Lower Kane was when I aimed my flashlight beam at one of the cave's three pools. Just below the water's surface stretched a crazy pattern of stringy, filmy matting in startling shades of blue-black, vermilion and garish Day-Glo orange, as if some 1960s pop artist had tossed paint in every direction. In some places, the mottled, pitted orange patterns reminded me of NASA images of the barren surface of Mars. In others, it looked as if someone had dumped spaghetti sauce in the water. And floating in the water directly over each spring, spidery white filaments, like delicate cobwebs, performed a ghostly underwater dance in the currents bubbling up from below.

The psychedelic colors all belonged to bacterial mats, gelatinous films of carbon compounds generated by invisible microbes. These vivid by-products of bacterial activity can be seen clustering around hot springs in Yellowstone and elsewhere, though on the surface they can be overwhelmed by competition from algae and other organisms. But what were they doing here in Lower Kane, thriving so abundantly in a place with poisonous gases and no sunlight?

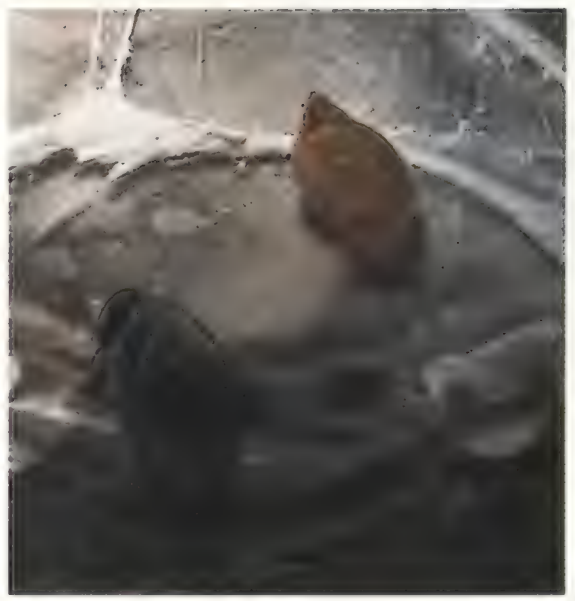
For most of the 20th century, scientists believed no bacteria could exist more than a few yards beneath topsoil or ocean mud; below that, scientists thought, life simply fizzled out. Then, in 1977, came the astonishing discovery of bizarre tube worms and other exotic animals, all huddled around submerged volcanoes so deep in the Pacific that sunlight does not reach them. This otherworldly ecosystem turned out to depend almost entirely on the activity of sulfur-loving bacteria, thriving on the scalding currents and gases released by undersea vents. Equally startling revelations about microbes in other unlikely places soon followed: bacteria were found in cores drilled more than a mile below Virginia, inside rocks from inhospitable Antarctica, and more than six miles deep in the Pacific at the bottom of the Marianas Trench. Some scientists now speculate that hidden subsurface bacteria may equal the mass of all living material above.

This "dark life," isolated for billions of years, opens up tantalizing prospects for scientists. Microbiologists hope that

underground bacteria can lead to new antibiotics or anticancer agents. NASA specialists are investigating them in hopes of identifying signatures that they might recognize in rock samples from Mars or in probes that may one day penetrate the frozen seas of Europa, one of Jupiter's moons.

But the challenge for all these hunters of subterranean bugs is access, which is where Lower Kane comes in. "Caves offer a perfect walk-in window to the normally hidden world of microbial activity," says Diana Northup, a cave investigator at the University of New Mexico. "Some researchers speculate that life evolved first underground and moved to the surface as conditions improved. If this is true, then studies of subsurface microbes may offer clues to the nature of some of earth's earliest life-forms."

Although Lower Kane Cave had given me a soaking and a bruise or two, my discomforts were nothing compared with the miles of wriggling and squeezing required to penetrate many other sulfide caves. Its accessibility was one reason Lower Kane attracted Annette Summers Engel first in 1999 and every year since, allowing her and her team of geologists, geochemists and DNA experts to haul scientific equipment in and out with relative ease. Their initial tests quickly confirmed that Stephen Egemeier had been right: sulfuric acid, the result of hydrogen sulfide reacting with oxygen, was indeed still eating away the cave walls. The most intriguing question was whether Lower Kane's bacterial mats were adding to the acid attack. Since some bacteria produce sulfuric acid as waste products, it certainly seemed possible. Summers Engel's plan was to tackle the question from several different angles. A DNA test, for example, might identify particular microbes. Other tests might tell whether a microbe fed on, say, sulfur or iron, and whether it was stressed or flourishing.



Snails thrive on the bacteria floating in filaments in a Lower Kane stream (top). Needlelike crystals of gypsum form as sulfuric acid eats away Lower Kane's walls (middle). Even the tiny (0.05 inch in diameter) droplets of sulfuric acid that drip from Lower Kane's walls and ceilings are rich with bacteria (bottom).

Preliminary results bowled over the researchers. "When we first came to Lower Kane," says Summers Engel, "we naturally assumed that each mat would mainly consist of sulfur-oxidizing microbes. That seemed like common sense. What we found, instead, was astonishing complexity." Each mat, in fact, turned out to be as diverse as a Manhattan city block. There were plenty of sulfur-eating microbes, all feeding off the gases bubbling up in the springs. But there was a riotous mix of other bacteria too. For example, some, oblivious to sulfur, were feeding off the waste generated by their neighbors. Nor were the bugs all thrown together at random. Sulfur-eating bacteria, for instance, congregated at the top of the mat; as greedy consumers of oxygen, they needed the air at the spring's surface to survive. Methane producers that need no oxygen were concentrated, predictably, at the mat's bottom.

To find out how the mats as a whole were affecting the cave, the scientists devised a test of elegant simplicity, involving two plastic tubes, each containing identical limestone chips. The mouth of one was covered with a crude plastic mesh, allowing both microbes and water from the spring to swirl inside. The other was covered with a membrane that admitted water but kept out the microbes. After submerging both tubes in the spring for several months, the team studied the chips under a microscope. The chip exposed to both the acidic water and the microbes was more severely pitted and scarred than the one exposed to water alone. Here was the proof that acid-producing microbes were accelerating the creation of the cave. "There's no question that microbes are adding to the acid chemistry that's dissolving the limestone," says University of Texas geochemist Libby Stern, "and that without the mats Lower Kane probably would be forming at a much slower pace."

But another find was even more tan-

Though unprepossessing in some ways, Lower Kane's scientific riches have drawn to its humid depths teams of researchers, including Libby Stern (left).

talizing: a totally new species of microbe, tentatively identified by Brigham Young University biologist Megan Porter. The new organism appears closely related to microbes found at undersea vents deep in the Pacific, a likely point of origin for the emergence of life. "This is an exciting discovery," says Porter, "because it implies that the types of metabolisms found in Lower Kane Cave are very ancient." It also fits with growing evidence that life may have begun in the depths. In subsurface havens like caves, undersea vents and in the soil, primitive microbes would have been sheltered from the volcanic blasts, meteor bombardments and intense ultraviolet radiation that made the planet so inhospitable in its early years. In these ancient refuges, which humans have only just figured out how to penetrate, life evolved far from sunlight, often in extreme conditions of heat and acidity. Kane's psychedelic mats remind us how extraordinarily diverse and hardy earth's ancient pioneers must have been.

But the horizons of cave research stretch far beyond our own planet. Many astronomers and geologists speculate that Jupiter's moon Europa and Mars each harbor water and subsurface conditions resembling our own. If microbes can survive in harsh conditions here, why not there as well? "Our work in caves has broadened the known limits of life on our own planet," says Penny Boston. "But it's also a great dress rehearsal for studying biological sites on other planets, and pushing our imaginations to connect earth's 'inner-terrestrials' with those of outer space."

Evan Hadingham, a NOVA *science editor, explained the workings of trebuchets, gigantic medieval catapults, in* SMITHSONIAN *in January 2000. Kevin Downey has made 2,000 trips underground in 31 countries to photograph caves.*

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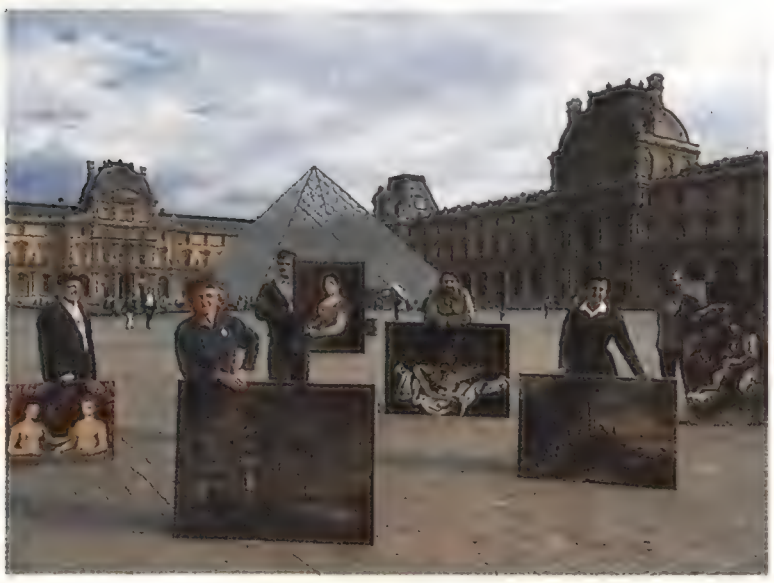
LIKE GENERATIONS OF PAINTERS BEFORE THEM, ARTISTS FROM AROUND THE GLOBE GO TO PARIS TO COPY THE MASTERPIECES AT THE LOUVRE

Master Class

BY JOSEPH A. HARRISS

THE LOUVRE HAS BEEN OPEN ONLY A FEW MINUTES, but already crowds are sauntering through its vast galleries. Up on the second floor, in a long, red-walled room devoted to 19th-century French paintings, a group is gathering around a young woman wearing a black velvet tunic and a floor-length silk skirt. Her glossy auburn hair braided and coiled around her head, she sits on a stool before an easel, deftly applying paint to a canvas. Some of the visitors hang back, stare dubiously, then wander off. Others crowd in for a better look, glancing from the famous 19th-century painting on the wall, The Women of Algiers by Eugène Delacroix, to the copy on the easel. "Boy, she's really good," someone whispers. "Aw, I bet she's doing it by the numbers," comes the response.



Sorrel Smith, a 25-year-old artist from California, is not only producing that curious paradox—an original, fully creative copy—she is also carrying on a venerable tradition. Ever since the museum opened its treasures to public view in November 1793 (one of the indisputable benefits of the French Revolution), it has allowed, even encouraged, artists to hone their skills by copying the masterpieces in its collections. Thousands have done so, including great classical painters from Turner to Ingres, Impressionists from Manet to Degas, and modernists like Chagall and Giacometti. "You have to copy and recopy the masters," Degas insisted, "and it's only after having proved oneself as a good copyist that you can reasonably try to do a still life of a radish."

For more than two centuries, copyists like these have flocked to the Louvre to learn from the masters. California artist Sorrel Smith (opposite, working on a copy of Delacroix's 1834 *The Women of Algiers*) likes to wear 19th-century dress "because it goes with the paintings at the museum."

PHOTOGRAPHS BY ERIC SANDER

Hubert Robert, one of the Louvre's first curators, included several copyists in his 1796 painting of a plan for the installation of the royal art collection in the museum's Grande Galerie. Today, the high volume of visitors makes copying in the popular gallery difficult.

The Louvre's attraction is profound. When 23-year-old Marc Chagall arrived in Paris in 1910 from Russia, he went there directly from the train station, suitcase in hand. "Going to the Louvre is like reading the Bible or Shakespeare," he later said. Paul Cézanne regularly trekked there to copy Michelangelo, Rubens and classical Greek and Roman statues. "The Louvre is the book where we learn to read," he declared.

Though most of them are women, today's copyists are an otherwise varied lot. Of the 150 artists who executed 269 copies during the 2000-2001 painting season, nearly three out of four were art students or in artistic professions. But there was also a psychoanalyst, a surgeon, a midwife and 13 retirees. Three out of four, also, were French, but there were 20 Americans, the largest foreign group. Maïten de Ferrier, the enthusiastic head of the office that runs the copyist program, believes a stint at the Louvre is a rite of passage. "These artists like to follow in the footsteps of all the great painters who have copied here," she explains. "And, of course, they also come to improve their technique, to find solutions to their artistic problems." Some, however—like eccentric Surrealist Salvador Dalí, who created a group of provocative renderings of Jean-François Millet's pious *The Angelus*—prefer to use masterworks as a point of departure. Picasso, who copied at the Louvre in the 1950s to recharge his creative batteries, produced a series of interpretations of Delacroix's *The Women of Algiers* (the same work now being copied by Sorrell Smith) after noticing a marked resemblance between one of the women in the painting and his then companion, Jacqueline Roque.

At the moment, Sorrel Smith's problem is getting Delacroix's composition and colors just right. An accomplished technician who likes to do miniature portraits on ivory, Smith came to Paris with the Wells College Program

REUNION DES MUSÉES NATIONAUX/ART RESOURCE, NEW YORK

"If you don't copy, you won't advance," says artist Mary Chavance. "But you can't do it passively."

for the Arts (Aurora, New York), where she learned to mix colors and stretch canvases. "Making my own paints with earth pigments means I don't have to search for the colors the old masters used, because I'm starting from the same point they did," she explains. "In this painting the colors are very vibrant and at the same time muted, creating a difficult balance. It's the hardest copy I've ever done."

Difficulty is what most Louvre copyists seek. "It's a challenge to try to reach the level of the old masters, and to meet it you have to extend yourself," says Mary Chavance, a French artist who does mainly Impressionist-style landscapes in her Left Bank studio. But here, on the opposite side of the Seine, in the Louvre's bustling Grande Galerie (devoted to French, Italian and Spanish classical paintings), she is grappling with an aristocrat in gleaming armor by Caravaggio. The work is typical of the Baroque artist's Tenebrism—the depiction of dramatically illuminated forms emerging from shadow. Her version looks perfect, but she's not satisfied. "If you don't copy, you won't advance," she says. "But you can't do it passively. You have to involve yourself deeply in creating something that's more than just a reproduction of a painting."

That seems to have been the idea when the museum opened its doors two centuries ago. "Each visitor should be able to put his easel in front of any painting or statue to draw, paint or model as he likes," proclaimed an early official. But the Louvre was soon so flooded with artists that the museum had to start issuing authorizations and limiting hours for copyists. (Today, copying is permitted from 9 A.M. to 1:30 P.M., September through June, except Tuesdays, Sundays and holidays.) In the early days, art students, never known for their decorum, often had to be reminded to refrain from games, singing and horsing around in what was supposed to be, according to Louvre authorities, a "sanctuary of silence and meditation."

Not everyone came to the Louvre for purely aesthetic reasons. In the mid-19th century, mothers often chaperoned their copyist daughters, concerned that representations of scantily clad bodies might be corrupting or that male copyists had more on their minds than offers of artistic instruction. To such prospective swains, the 19th-century novelist Champfleury offered an effective approach: "Copy a painting next to hers, then ask to borrow some cadmium or cobalt. Then correct the odious mess of colors she calls a painting (they're always glad to get advice) and talk about the Old Masters until the Louvre closes and you have to continue the conversation in the street. Improvise the rest."

By the middle of the 19th century, hundreds of artists were busily copying masterpieces, mainly to satisfy orders from clients. Many visitors, wending through a veritable forest of easels, ordered copies on the spot. Thus the Louvre offered artists the possibility of income (though by the 1890s, photography had reduced demand), as well as a dry and heated place to work.

Still, many of today's Louvre copyists sell their works. A few art galleries near the museum market them, and some artists, such as Amal Dagher, who has been copying for 30 years and is considered the unofficial dean of Louvre copyists, sell directly to visitors. Born in Lebanon, the affable 63-year-old Dagher studied for four years at Beirut's Academy of Fine Arts, and later in India, Thailand and Japan, before settling in Paris. He is working on a copy of a portrait of Mademoiselle Caroline Rivière by French neoclassicist Jean-Auguste-Dominique Ingres, who, along with Delacroix, is among the most copied of the Louvre's masters because of his rigorous composition and subtle coloring. (One of the world's most famous paintings, Leonardo's *Mona Lisa*, is one of the least copied—partly because the crowds that flock to the painting make it hard for an artist to set up an easel and partly because, according to Ferrier, its fame intimidates.)

"Caroline Rivière died at 14, about a year after she posed for Ingres," says Dagher. "I believe he was trying to present an idealized vision of her. She is almost an Italian Madonna, and the challenge here is to achieve the form that he gave her, making her seem to float above the background." Despite his many years of copying, Dagher admits to feeling a sort of stage fright every time he faces a blank canvas. "That's a good sign," he says. "If you're too satisfied with yourself, you can't improve."

Dagher also values the Louvre for the access it gives him to the

MARC VAUX/PHOTOGRAPHIC ARCHIVES, NATIONAL MUSEUM OF MODERN ART, CENTRE G. POMPIDOU, PARIS

"I used to study the great masters," said Henri Matisse (sketching at the Louvre c. 1946), "just like in literature one studies the great authors."

public. "Not many people passing through actually buy my copies," he says, "but often they will ask me to do something else for them." Some want him to make copies of portraits of their ancestors so they can give them to other family members. One American visitor asked him to paint a reproduction of a Versailles ceiling fresco at the visitor's home in Connecticut. "The gold-leaf molding alone cost nearly $60,000," Dagher recalls. "That was a lot more than I asked for doing the painting."

But not everyone wants to sell their copies. Gilles Malézieux is interested only in creating his own collection. Malézieux, 45, knows the Louvre better than most. He works there as a security officer. When not keeping an eye out for pickpockets, he returns to the museum with brushes and paint. "I take days off from my vacation time to do this," he says. "I'd rather copy than go to the beach." Malézieux began copying six years ago because he loved paintings but couldn't afford to buy them. Self-taught, he does four or five copies a year. He's currently working on a rendering of *The Ferry* by 17th-century Dutch landscape painter Salomon van Ruysdael. "I chose this one because it's a seascape—a glaze without much detail," he says. "That lets me dream a little, and that's enough vacation for me."

Not far away in a room given over to 17th-century Dutch painters, Tsutomu Daitoku is hard at work on a copy of Jan Vermeer's *The Lacemaker*, with its assiduous young lady bending to her delicate handiwork. Tall, thin and earnest-looking, the 25-year-old Japanese amateur taught himself to paint by reading books and studying works in museums. "I came to Paris just so I could copy here at the Louvre," he says. "I plan to become a professional artist when I return to Japan, moving around the country and doing all kinds of paintings. This one by Vermeer is very difficult, especially the"—he consults a Japanese-English pocket dictionary—"'coloring.'"

In order to copy at the Louvre, non-French artists like Daitoku must attach a photocopy of their passport and a recommendation from their embassy or consulate to their application, but otherwise the procedure is the same as for French citizens—a simple form specifying the desired starting date and the painting to be copied. No samples of work are requested. Permits are good for three months, and the museum provides each artist with an easel and stool. Except for the requirement that copies be one-fifth smaller or larger than originals and that the artist's signature cannot be reproduced, the Louvre imposes very few rules on copy-

Amal Dagher (at home in his studio near Paris, amid his renderings of paintings by Caravaggio, Raphael and other masters) has copied hundreds of works at the Louvre over the past 30 years. "I don't copy in a mechanical manner," he says. "I put my feelings inside."

American Will Thompson (above, with his take on Goya's *Young Woman with a Fan*) has been copying at the Louvre since 1994. A retired maître d', Bruno Nini (right) was drawn to paint Géricault's *Officer of the Imperial Guard* by "the palpitating beauty of the horse."

ists, though it further protects against any temptation to produce a forgery by affixing an official stamp to both sides of each copy and carefully inspecting the works before they leave the museum. "But this is not a problem we have here," says Ferrier. "If someone really wants to make a forgery, it's much simpler to work from a good color photograph in the secrecy of their own studio."

The Louvre is more liberal than, say, Washington's National Gallery of Art, which has a long list of rules and requires reference letters, original samples of paintings and an interview from applicants. But the Louvre's Ferrier thinks that "we should leave the artists as free as possible." One painter who has benefited from this attitude is American Will H.G. Thompson, a slender man of 30 with thick dark hair. A professional artist who won an award for a painting at Paris's Salon des Beaux-Arts, Thompson was born in Switzerland and grew up in Europe. He studied art at the Pennsylvania Academy of Fine Arts in Philadelphia and now makes his home in Paris. In a dimly lit room devoted to Spanish classical paintings, he is copying Francisco de Goya's *Young Woman with a Fan*, a portrait of a poised young lady with a distant, dreamy gaze.

"I got a good foundation at the Pennsylvania Academy, but you never stop learning," Thompson says. "When I copy a masterpiece, I get a sort of mental trip out of it, applying the paint differently, using light and dark the way the artist did. It's like taking a lesson from an old master."

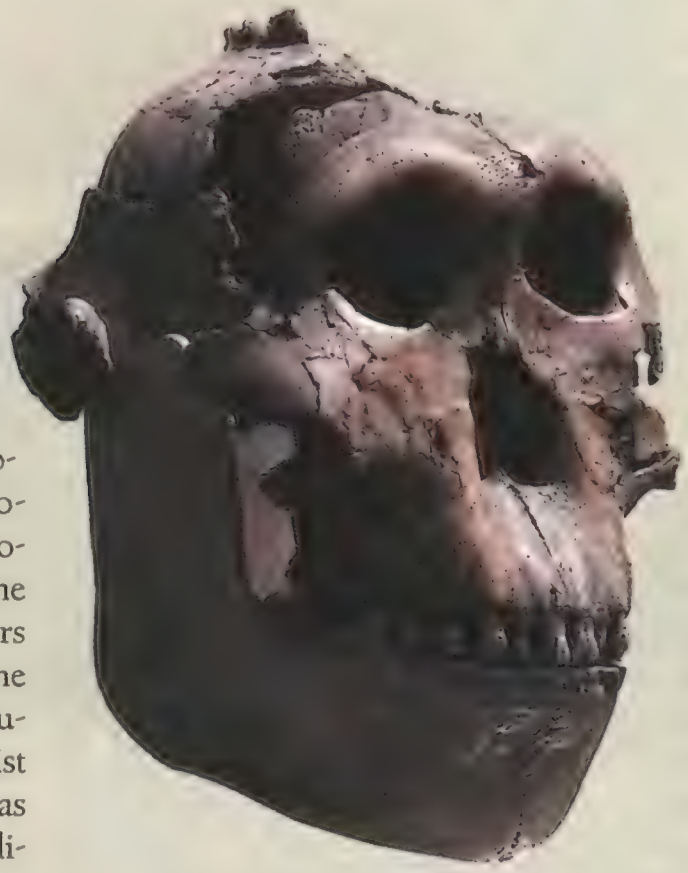
Like most Louvre copyists, Thompson often chats with some of the thousands of visitors who enter the museum each day. "There's a real exchange between the copyists and the public that we consider very positive," says Ferrier. "Copyists working amid the visitors enhance the way the public sees paintings and incites them to look more closely with a more analytical approach. They start noticing how the artist actually did the work."

Those who frequent the museum have come to know a small man of 77 with pale blue eyes and a gentle manner. Bruno Nini has been copying nearly every day since 1990, when he retired as maître d' at a restaurant in Paris's Austerlitz train station, where he began his days by taking delivery of 5,000 croissants at 5 A.M. Now he is working on a copy of *Gabrielle d'Estrées and One of Her Sisters*, a tantalizing portrait of the mistress of Henri IV by an anonymous 16th-century painter of the school of Fontainebleau.

"I learned most of my technique from books," Nini says with obvious pride. "After realizing I wanted to paint, I sought out street artists and tried to get tips from them. Then one day I came here and saw copyists at work. I knew that was what I wanted to do." Nini estimates he's done more than 100 copies, some of which he's sold; the others hang on the crowded walls of his Paris apartment. He's an amateur in the truest sense of the term—someone who passionately loves what he's doing. "Sometimes, when I see the figures in a painting coming to life under my brush strokes," he says, "tears come to my eyes."

Paris-based writer Joseph A. Harriss visits the Louvre regularly but has never copied there. Photographer Eric Sander also lives in Paris.

THE OLD MAN OF OLDUVAI GORGE



IRREPRESSIBLE LOUIS LEAKEY, PATRIARCH OF THE FOSSIL-HUNTING FAMILY, CHAMPIONED THE SEARCH FOR HUMAN ORIGINS IN AFRICA, ATTRACTING CRITICISM AND PRAISE

BY ROGER LEWIN

Louis Leakey (opposite, with the broken molar of a dinothere, an extinct elephant-like mammal) was convinced that Africa, not Asia, was the birthplace of early humans. "Zinjanthropus" (above, with a reconstructed lower jaw), discovered by his wife Mary, garnered worldwide attention.

MORE THAN ANYONE, Louis Leakey established paleoanthropology as a high-profile endeavor. By the time he died 30 years ago this month, his name had become synonymous with the search for human origins. A passionate naturalist and an astute chronicler, Leakey was also a showman who tirelessly publicized his discoveries to admiring audiences around the world. "He loved to be recognized, and to stimulate people by talking about what he'd done and who he was," his son Richard, 57, himself an expert fossil hunter, has said.

Louis pursued a breathtaking range of interests. He studied fossil bones, stone artifacts and cave paintings. He published monographs on the social customs of the Kikuyu people of Kenya and the string figures, comparable to cat's cradles, made by people in Angola. Believing that the behavior of monkeys and apes held clues to the nature of our evolutionary ancestors, he established a research station in Kenya near Nairobi for the study of primates, and he encouraged such now-famous researchers as Jane Goodall, Dian Fossey and Biruté Galdikas to live in the wild with, respectively, chimpanzees, gorillas and orangutans. Long before wildlife conservation became popular, Leakey helped establish national parks in Kenya. He was an expert stone knapper, or toolmaker, and would delight in making sharp implements with which he would swiftly skin an animal whenever he had an audience. His knowledge of animal behavior was encyclopedic, and he was a keen ornithologist, which he had once thought would be his career.

"Everything Louis did, he did with enthusiasm," remembers Andrew Hill, professor of anthropology at Yale. "He'd even be enthusiastic about the breakfast he prepared or the dinner he cooked. It could get a little wearing, especially at breakfast if you weren't a morning person." Perhaps not surprisingly, some colleagues found Leakey's eclecticism off-putting. "It annoyed a lot of people, who felt that with such a broad range of interests, he couldn't possibly be taking seriously their chosen field of study," says Alan Walker, professor of anthropology and biology at Penn State. To critics, Leakey seemed more dilettante than Renaissance man.

Although Louis grabbed the headlines, it was his second wife, Mary, an archaeologist, who made many of the actual finds associated with the Leakey name. Until later in their relationship, when their marital ties all but snapped

Born in Kenya in 1903 to Anglican missionaries, Louis Leakey (in his mother's arms outside the family's mud and thatch house) was initiated as a youth into the Kikuyu tribe. "I still often think in Kikuyu, dream in Kikuyu," he wrote in a 1937 autobiography.

for both personal and professional reasons, she let her husband bask in the limelight while she conducted her beloved fieldwork.

Louis Leakey was an easy target for critics, partly because he flouted social convention but mainly because several of his most dramatic claims turned out to be wrong. In his excitement, he sometimes announced a bold new theory before marshaling all the available evidence—an approach that is anathema to careful science. He was a maverick by any standard—"anything but typically English," as he said of himself—and scorned bookish academics who were "only prepared to devote a few months to [field] research and then return to more lucrative and comfortable work in the universities." Yet, paradoxically, he also longed to be accepted by academia and to be elected a fellow of the Royal Society, Britain's most prestigious scientific organization.

That honor eluded him, however. For one thing, some of his colleagues regarded Leakey's flamboyant, sometimes fanciful writings as not sufficiently scientific. But his personal life was also an impediment. When he was 30 years old, he had scandalized Cambridge colleagues by leaving his wife, Frida—she was at the time pregnant with his second child—to be with Mary Nicol, whom he later married. Even more damaging to his fellowship chances, in Leakey's own view, was the time he privately criticized an article by Sir Solly (later Lord) Zuckerman, a powerful member of the society and chief scientific adviser to the British government. According to Leakey family biographer Virginia Morell, Leakey believed that it was Zuckerman who repeatedly blocked his election to the Royal Society.

In keeping with the archetype of the preoccupied scientist, he was notoriously indifferent to his appearance; on the rare occasion he wore a necktie, Hill recalls, "it was usually skewed and stained with food or something." But his charisma was impeccable. "He could charm the birds out of the trees," Mary Smith, an editor at the National Geographic Society, which supported Leakey's work, told biographer Morell. Rosemary Ritter, an archaeologist who worked with him in California, has said Leakey "had a way of making even the littlest, most unimportant person feel important. That's why people were so willing to work for him."

Leakey had a magnetic effect on many women. Irven DeVore, professor emeritus of anthropology at Harvard, recalled to Morell his first encounter with Leakey, in Nairobi in 1959: "He was dressed in one of those awful boiler suits, and he had a great shock of unruly white hair, a heavily creased face and about three teeth. . . . When my

LEAKEY FAMILY COLLECTION; P. 82 BOB CAMPBELL; P. 83 MELVILLE B. GROSVENOR/NATIONAL GEOGRAPHIC IMAGE COLLECTION

wife, Nancy, and I got back to our hotel, I said to her, 'Objectively, he must be one of the ugliest men I've ever met.' And she said, 'Are you kidding? That's the sexiest man I've ever laid my eyes on.'" Leakey understood his appeal to the opposite sex and philandered with characteristic enthusiasm. His amatory rambles eventually undermined his marriage to Mary.

Born in Kabete, in colonial Kenya, he was the son of Harry and Mary Bazett Leakey, who ran an Anglican mission northwest of Nairobi. Louis spent much of his youth among Kikuyu children, and his three siblings were often his only European peers. From the Kikuyu he gained a sense of intimacy with nature that instilled a lifelong passion for wildlife. Shipped off to public school in England at age 16, he later described himself as "shy and unsophisticated" and awkwardly out of touch with the English way of life.

Still, he attended Cambridge University, his father's alma mater, where he earned a bachelor's degree in archaeology and anthropology and, later, a doctorate for his research in East Africa. His plans to search for early human remains in Africa had met with skepticism. "There's nothing of significance to be found there," he recalled being told by a Cambridge professor. "If you really want to spend your life studying early man, do it in Asia." *Pithecanthropus*, now called *Homo erectus*, or erect man, had been discovered in Java just before the turn of the century, and in the 1920s a similar kind of early human, called Peking man, had been found in China.

Leakey stubbornly followed his instincts. "I was born in East Africa," he would later write, "and I've already found traces of early man there. Furthermore, I'm convinced that Africa, not Asia, is the cradle of mankind."

Charles Darwin, in his 1871 book *Descent of Man*, had suggested that because our closest evolutionary relatives, chimpanzees and gorillas, live in Africa, the earliest humans probably once lived there too. Leakey was just 13 when he decided to devote himself to the study of prehistory and find out if Darwin was right. As a young man, he thus challenged the conventional wisdom, which appealed to his contrarian nature. "I became excited with the idea that everyone was looking in the wrong place," he later explained. In the fall of 1931, on his third expedition to East Africa but his first to Olduvai, he found primitive stone axes in ancient sediments, evidence that ancestors of humans had indeed lived in Africa. It was a significant discovery—"I was nearly mad with delight," he recalled—but Leakey's penchant for over-reaching soon got the better of him.

A 1935 expedition to Olduvai turned up elephant fossils and cemented the relationship between Leakey (center) and archaeology student Mary Nicol (right). They wed in 1936.

In addition to staking his career on the notion that Africa was the cradle of humankind, he also believed, given the fossil evidence, that the earliest bipedal human ancestors, or hominids, must have existed hundreds of thousands of years earlier than most other scientists were willing to say. Indeed, the reason for that first trip to Olduvai Gorge was to test the idea that a modern-looking skeleton, discovered by German scientist Hans Reck in 1913, was, as Reck claimed, about half a million years old—the age of the deposits in which it had been found.

Leakey, initially skeptical of Reck's assertions, visited the site with Reck and soon agreed with him. They coauthored a letter to the British journal *Nature* reporting the new evidence for Reck's original theory—which also appeared to confirm Leakey's hunch that our first true ancestor lived farther back in prehistory. "[Reck] must be one of the few people who succeeded in swaying Louis once his mind was made up," observes Leakey's biographer Sonia Cole. But a few years later, other researchers, using improved geological methods, concluded that the skeleton wasn't ancient at all, but had simply been buried in far-older sediments.

In 1932, Leakey was also making extravagant claims of antiquity for fossils from two sites in western Kenya, Kanam and Kanjera. The Kanam jawbone, Leakey boldly announced, was

LEAKEY FAMILY COLLECTION

Leakey (at Olduvai c. 1961 with Mary and son Philip—later the first white member of Kenya's parliament) was a man of many enthusiasms.

"not only the oldest human fragment from Africa, but the most ancient fragment of true *Homo* yet to be discovered anywhere in the world." Ultimately, it was found that the Kanjera and Kanam specimens were relatively recent. Leakey's reputation already had taken a beating when a British geologist visited Kanjera and reported that Leakey did not know exactly where he had found his famous fossil—an astonishing lapse for an anthropologist.

Leakey shrugged off his critics. He and Mary pressed on, and in 1948 they received their first real taste of public adulation with the discovery of a little skull of an 18-million-year-old ape called *Proconsul*. It was the first fossil ape skull ever found, and Mary flew with it to England so that Wilfrid Le Gros Clark, Leakey's friend and an anthropologist at Oxford, could examine the specimen. The plane was met by reporters, photographers and newsreel cameramen. Later, with the skull on display at the airport, Mary told Leakey, "Two plainclothes detectives assigned to guard it never let it out of their sight."

Then, in 1959, came the now-famous discovery, in Olduvai, of a 1.75-million-year-old skull that Leakey named *Zinjanthropus boisei*, and which he asserted was the "connecting link between the South African near-men . . . and true man as we know him." The skull was similar to those of the robust ape-man creatures that had been found in South Africa, but differed from them in having heavier bones and bigger teeth. Nearly three decades of work had at last been rewarded, it seemed, and the huge publicity surrounding the find propelled the Leakeys—particularly Louis, though Mary had actually discovered the skull—to still greater fame.

Louis embarked on a speaking tour in the United States and Europe, and established a long and close relationship with the National Geographic Society, which publicized the Leakeys often in its magazine and provided them with financial support. In November 1960, 19-year-old Jonathan, the eldest of the couple's three sons, made a discovery that was even more important than *Zinjanthropus*. Working near the Zinj site, he found a jawbone that was even more humanlike. It came to be known as pre-Zinj, because it was unearthed from deeper sediments and presumed to be older than *Zinjanthropus*. (Leakey later reclassified *Zinjanthropus* as an australopithecine; it is now generally known as *Paranthropus boisei*.)

In time, and as the Leakey team uncovered more fossil material, Louis became convinced that pre-Zinj was the ancient species of *Homo* he'd been seek-

ROBERT F. SISSON/NATIONAL GEOGRAPHIC SOCIETY IMAGE COLLECTION

ing for so long. It had a bigger brain and was less ruggedly built than the so-called ape-men. He called it *Homo habilis*, or handy man, a reference to the stone tools at the site that Leakey was convinced the creature had made, and he believed it to be the ancestor of modern humans, *Homo sapiens*.

In 1964, Leakey and two coauthors submitted their findings on *Homo habilis* to the journal *Nature*. The response was fast and largely furious. Anthropologists dispatched condemnatory letters to the London *Times* and scientific journals. Their message: pre-Zinj was nothing more than an australopithecine, not a separate species of *Homo*. Part of the criticism was that in naming the new species, Leakey brashly changed the definition of *Homo* so that pre-Zinj would qualify. For example, at the time, a species of ancient human could be called *Homo* only if its brain were at least 700 cubic centimeters in volume. By this standard, pre-Zinj was something of a pinhead, with a brain of just 675 cubic centimeters (the average human brain has a volume of 1,300 cc).

Partners for decades, Louis and Mary (with Zinj jaw and human skull in 1959) would split over personal and scientific differences.

Other discoveries that Leakey made in the 1960s also generated controversy. On an island in Lake Victoria, he found fossil evidence of two new primate species that he said pushed back the origins of human beings by millions of years. His claims were immediately met with harsh criticism. He called the primates *Kenyapithecus*. One species was 20 million years old. He named it *africanus* and claimed that it was the oldest hominid ever found. Experts disputed the claim then, arguing that it was a fossil ape, which remains the prevailing view. The other species, *Kenyapithecus wickeri*, was some 14 million years old. Its pedigree is checkered. Leakey first said it was more ape than human, but later modified that view. Scientists now believe that it is the most advanced fossil ape of its period in East Africa.

Leakey astounded his colleagues again when, at a scientific meeting in 1967, he argued that a lump of lava found at the Lake Victoria fossil site had been used by *Kenyapithecus wickeri* as a tool. The announcement, made with Leakey's usual flourish, fell flat. Not one scientist in the audience asked a question, probably, as paleoanthropologist Elwyn Simons later observed, because they considered the idea "outlandish." Mary Leakey, too, was unconvinced. "I can't believe he really thought it was a 14-million-year-old stone tool," she told biographer Morell after Leakey's death. The incident, Morell writes in her 1995 book *Ancestral Passions*, "added to a growing suspicion that [Leakey's] scientific judgment was slipping."

It's in the nature of paleoanthropology to undergo constant revision, as was made clear this past summer, when a new contender in the quest for the earliest hominid was announced. A six- to seven-million-year-old skull, found in Chad by paleoanthropologists from France, is older and yet appears more modern in several key respects than specimens from more recent times. Those features, plus its discovery far from Kenya or Ethiopia (the other leading candidates for the place where human beings split from the common ancestor we share with apes) are prompting experts to reconceptualize the human family lineage.

By the late 1960s, Leakey was little involved in fieldwork, partly because of ill health but also because he was devoting so much time to raising money for the many research endeavors he oversaw. He was, however, directing a dig at Calico Hills, east of Los Angeles. Hundreds of stone flakes had been recovered from the site, and the excavators believed them to be human artifacts. That was an extraordinary claim because the site was as much as 100,000 years old, and most anthropologists believe that humans came to the Americas no earlier than 30,000 years ago, and probably much more recently.

Leakey's support of the Calico claim dismayed not only his friends and colleagues, but also Mary, and it would become a factor in their estrangement. In a poignant section of her autobiography, she characterized his position as "catastrophic to his professional career and . . . largely responsible for the parting of our ways."

Yet despite his occasionally misplaced enthusiasms, Leakey remains a seminal figure. "Although Louis was not highly regarded for his science," says Penn State's Alan Walker, "he made a major contribution in opening up East Africa for paleoanthropological

BETTMANN/CORBIS

Son Richard (right), who has played a role in Kenyan politics and conservation, added to the Leakey legacy with key fossil discoveries. His wife, Meave (left), and daughter Louise, both paleontologists, lead excavations in Kenya, which noted a family find with a stamp.

exploration, making the science possible." Others remember his pioneering spirit. "He had an energizing effect on the field and on the people doing the research," says David Pilbeam, professor of anthropology at Harvard. "He could be sloppy and brilliant, prescient and foolish. But, given the time [in which] he was working, overall his instincts were right."

So right, in fact, that Leakey's view would prevail and most anthropologists would eventually accept *Homo habilis* as a legitimate member of the human family, though not necessarily as the direct ancestor of *Homo sapiens*. Inspired by his father's work on human origins, third son Richard Leakey has achieved fame for his own fossil discoveries. In late September 1972, Richard flew down to Nairobi from his research site at Lake Rudolf (now Turkana) to show his father his team's latest find, a large-brained skull thought at the time to be 2.6 million years old. The specimen was named 1470.

"It's marvelous," exclaimed Louis. "But they won't believe you." Remembering his own experience with the skeptics, Louis was looking forward to the fight over whether 1470 was a species of *Homo*, which Richard argued it was. As Richard recalled the encounter, the skull "represented to [Louis] the final proof of the ideas he had held throughout his career about the great antiquity of quite advanced hominid forms."

But on October 1, a few days after holding the fossil in his hands, Louis Leakey died of a heart attack on a visit to London. Thirty years later, the debate that he anticipated continues.

Roger Lewin is the author of several books on human origins, including Bones of Contention (1987), *and has coauthored five books with Richard Leakey.*

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Going to Extremes

WITHOUT THE EXTRAORDINARY DEDICATION OF A FEW CONSERVATIONISTS, NEW ZEALAND'S KAKAPO WOULD LIKELY HAVE GONE THE WAY OF THE DODO ◆ **BY DEREK GRZELEWSKI**

THE HELICOPTER HOVERED ABOVE THE SURFACE for a moment, then crashed into the water and began to sink. Inside, three men took in huge lungfuls of air. "One . . . two . . . three," they counted, ". . . four . . . FIVE! Go!" They wiggled out, pushed open the door and shot toward the light. Two of the men burst to the surface and sucked in air while a third surfaced calmly. "That was good, gentlemen," the third man said, floating alongside the two gasping ornithologists, "but we'll have to do it again. Just so that you really get it nailed." Technicians raised the helicopter simulator above the pool and prepped it for another drop.

Even among birders, who are renowned for the lengths they will go to indulge their passions, Don Merton, 63, and Graeme Elliott, 45, are a breed apart. Merton is the most senior member of New Zealand's government-run Kakapo Recovery Programme, and Elliott is its research scientist. Their efforts on behalf of the shy, flightless parrot known as the kakapo include airlifting the few remaining birds to a remote and predator-free island in the Pacific. This island's shores are so rugged that few boats can land. Thus the need for Merton and Elliott to undergo this rigorous helicopter training.

Why all this trouble for a bird? Having encountered a kakapo firsthand, I think I understand. During the release of a bird called Sirocco on Codfish Island, located off the southern coast of New Zealand's South Island, I watched as he climbed out of his box, shuffled up a horizontal branch and stretched his powerful limbs in a ballerina-like posture, using his wings for balance. I reached out my hand slowly, and Sirocco touched it with his stubby beak, then unceremoniously leaped onto my arm as if it were an extension of the branch and climbed up to perch on my shoulder. He put his flat, owl-like face—its wide brown disks around the eyes and a beak nearly obscured by feathery whiskers—next to mine, then stretched out toward a fresh shoot of a fern and began to munch noisily. He reminded me of a Persian cat.

Even after nearly three decades studying kakapos, Merton's eyes still shine behind his square gold-rimmed glasses when he talks about them. He wears a shy

"It hops like a sparrow and growls like a dog," says an observer of the endangered kakapo, which survives today largely because of Don Merton (above, with one of the rare birds).

smile and a big backpack and is happiest in the forest. Perhaps best known for his early 1980s rescue of the Chatham Islands black robin, whose numbers once dipped to five—including only two females—he has helped save a number of other species in Mauritius, the Seychelles, and Christmas Island. No bird, however, has tested Merton's resourcefulness as much as the kakapo, which he calls "my ultimate challenge." For 30 years now, in an effort unprecedented in the history of New Zealand conservation, Merton has been fighting a largely losing battle to keep kakapos alive: their numbers have declined steeply over the past century, and the bird is perilously close to extinction. The remaining population—86 birds—has stabilized but is aging.

THE KAKAPO WAS ONCE ABUNDANT THROUGHOUT NEW ZEALAND from sea level to snow line. "The birds used to be in dozens round the camp, screeching and yelling like a lot of demons, and at times it was impossable [sic] to sleep for the noise," wrote the 19th-century explorer Charlie Douglas. On moonlit nights, Douglas went on, one could shake a tree and kakapos dropped like ripe apples. He also observed that their firm, fruity white flesh made "very good eating."

On moonlit nights a hundred years ago, one could shake a tree and kakapos dropped like ripe apples.

Although New Zealand abounds in faunal oddities such as the kiwi bird, none of its creatures have attracted quite as much attention recently as the kakapo. Local newspapers raptly follow their sex lives, and the government sponsors nationwide contests for schoolchildren to name fledglings. But for all the ink spilled on the bird's behalf, few people have ever seen one in the wild—and not only because it lives in remote sanctuaries but also because the kakapo has excellent camouflage and engages in a "freeze and blend in" strategy. It's a strategy that works well against eagle-eyed raptors but does little to safeguard it against tree-climbing predators that hunt by smell. "If the bird only knew its powers, it wouldn't fall such an easy prey to stoats [a kind of weasel] and ferrets," Douglas wrote in 1899. "One grasp of his powerful claws would crush either of those animals, but he has no idea of attack or defense."

The kakapo, of course, recalls the dodo (the former resident of what is now the island of Mauritius, east of Madagascar in the Indian Ocean), which became extinct 300 years ago. Like the dodo, the kakapo is a large and solitary creature too heavy to fly. Also like the dodo, it nests on the ground. Like the kakapo, the dodo was numerous and long-lived and a slow and infrequent breeder, which meant it could not bounce back once its population was diminished.

To be sure, the kakapo was once *considered* extinct: the aboriginal people of New Zealand, the Maori, hunted them with such gusto that by the time Europeans arrived in the

Slow breeders, kakapos hatch chicks (above) only once every three to five years, a trait similar to the extinct dodo (inset).

DON MERTON; NATIONAL LIBRARY OF AUSTRALIA, CANBERRA, AUSTRALIA/BRIDGEMAN ART LIBRARY

early 19th century, the bird had largely disappeared from North Island, the more populous of the country's two main islands. European settlers, along with the pets and vermin they brought with them, accelerated the decline. Between 1949 and 1973, the government wildlife conservation agency launched more than 60 search and rescue expeditions, mainly to the inaccessible mountains in the southwestern region of South Island, the kakapo's final bastion, a tract of large beech forests and Yosemite-like rock faces.

In the 1960s, five birds were trapped in South Island's Fiordland National Park, but all died in captivity. In the park in 1974, Merton heard what he was certain were the distinctive shrieks and screams—somewhere between a donkey's bray and a pig's squeal—of an agitated kakapo. It took him two weeks to trap the old, bedraggled male, whom researchers named Jonathan Livingston Kakapo. Over the course of the next three years, Merton and a half-dozen other volunteers combed the dense forest and cliff faces, turning up 17 additional males and a couple of mysteries: Where had all the females gone and what should they make of the immaculately groomed trails they found in the heavy vegetation, punctuated by round bowls of exposed earth about 1 1/2 feet wide and 5 inches deep? It appeared, recalled volunteer Rod Morris, as if "we were stumbling across the ruins of a tiny, ancient civilization." What did the birds use these bowls and trails for?

Merton knew that Maori lore told of a *whawharua*—a secret playground where kakapos gathered to perform mysterious nightly rituals. As he and other researchers examined the freshly used bowls and tracks, the Maori story began to appear almost plausible. The area, the biologists concluded, was a kakapo nightclub of sorts, where males would gather to prance, display and make loud vocalizations in hopes of attracting elusive females.

Merton and his colleagues learned that the male kakapo, puffed up like a feathered balloon, sits inside his bowl, which serves as a small amphitheater, and sends out a pulsing, low-frequency call, known as booming, which sounds at first like someone blowing across the top of an empty milk bottle. As the calls continue, sometimes for as long as eight hours, the intensity increases until it resembles the blast of a foghorn: *Oooom! Oooom!* The long-wave hum can travel up to three miles.

In 1977, against all odds, Merton and four two-man teams came upon an estimated 200-strong population of kakapo on 670-square-mile Stewart Island, New Zealand's third largest, about 100 miles south of Fiordland. Again, all were male. Merton despaired. Had every female kakapo been wiped out by some disease or predator? Was the species doomed? Not until 1980 did a tracking springer spaniel on Stewart Island pick up a kakapo scent and lead its handler to a smaller, more slender and greener bird. Merton examined it and declared that the search for a female was over. Four other female kakapos, along with their nests and chicks, were discovered in the vicinity soon after.

But Merton's jubilation would prove short-lived. After

Male kakapos (like this one, below, in Fiordland) will cluster together and spread their wings in a courtship dance called lekking.

Puffed up like a feathered balloon, the male kakapo sends out a pulsing, low-frequency call like a foghorn blast.

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the first female was banded and released on Stewart Island, she disappeared. Soon after, researchers began finding kakapo carcasses. Within two years, the known population of adult kakapos on the island decreased by nearly 70 percent, probably due to feral cats. Again, the bird hovered on the brink of extinction. A new policy was called for.

Over a decade starting in 1982, the 61 surviving Stewart Island kakapos were captured and transferred to Little Barrier, Maud and Codfish, three small, nearly predator-free island sanctuaries.

THEN, IN 1999, ON MAUD ISLAND, MERTON DISCOVERED A NEST containing three eggs. "We've waited more than 20 years for this nest," he said to his team. "It must succeed!" The nest was perched on a slope so steep that researchers had to cut a winding staircase of 140 steps to reach it.

Along with scientist Graeme Elliott and team leader Paul Jansen, Merton organized round-the-clock surveillance of the mother kakapo, whom they named Flossie. Whenever she left the nest at night to forage, a team of researchers moved in. They constructed a three-foot-high wall to prevent any eggs from rolling downhill and a plywood roof over the nest. And they dug a drain above the

Each nestling was eating 1,000 rimu nuts every time it was fed, sometimes four times a night.

nest to divert heavy rainwater away from it. Flossie's movements in and out of the nest set off a door chime that alerted researchers to her comings and goings. A miniature video camera kept an electronic eye on the chicks. Under this intense scrutiny, several broods, totaling 12 chicks in all, grew up over three seasons, raising the overall kakapo population, which had seen several deaths since 1982, to 62 birds.

THERE MATTERS STOOD UNTIL 2001, WHEN researchers on Codfish Island noticed that the rimu trees there, sources of a nut (encased in a fleshy aril) that they believe somehow triggers kakapo breeding, appeared poised to deliver a bumper crop of fruit. In anticipation of the bounty, they airlifted 9 female kakapos from Maud Island to join 12 females aready on Codfish. "This will be our moment of truth," said Merton.

While the predictions of rimu plentitude proved accurate, the magnitude of the kakapo baby boom that resulted from it took even Merton by surprise. In 24 nests (four of the females nested twice), the research team found a total of 67 eggs. Once the eggs hatched, researchers got another surprise. Each nestling was eating up to 1,000 rimu nuts every time it was fed, sometimes four times a night. The kakapo mother had to gather rimu nuts furiously, at the pace of some 16 every minute. "This is all the more remarkable," Merton says, "if you remember that the kakapo is

Kakapos eat many fruits but particularly enjoy rimu fruit (inset), which seems to encourage breeding.

GIDEON CLIMO; DON MERTON

flightless, and that it gathers its food at night, high in the forest canopy." During the eight-month period between conception and the time when their chicks leave the nest, kakapo mothers were losing as much as a third of their body weight.

By summer's end, 24 new birds, including 15 females, had raised the overall kakapo population to 86. "I think the kakapo have now turned the corner," Merton told me. "They are on the way to recovery." Still, he worried.

At a cost of about $500,000 per year, the Kakapo Recovery Programme is a major expense. If rescue and breeding efforts on the islands stopped for financial or political reasons, the bird would likely go the way of the dodo. To prevent that scenario, Merton and his colleagues hatched a plan to create a self-sustainable kakapo population on Campbell Island, which is located halfway between New Zealand and Antarctica.

Not only is this remote island predator-free and covered with fruiting plants that will provide plenty of food for the kakapos, but Campbell is also big enough, at nearly 44 square miles, to support a large and growing population. An indigenous snowgrass that has a fruit similar to the rimu should help satisfy the demanding nutritional needs of the chicks. The kakapos should adapt well to the cold there, because they have as much as a half-inch layer of fat under their skin.

Merton, along with his team and six kakapos, hopes to transport the birds to Campbell Island next year when the local plants are fruiting abundantly. A fixed-wing airplane equipped with emergency life rafts will accompany the helicopter containing researchers and kakapos on the nearly ten-hour round-trip flight to the island.

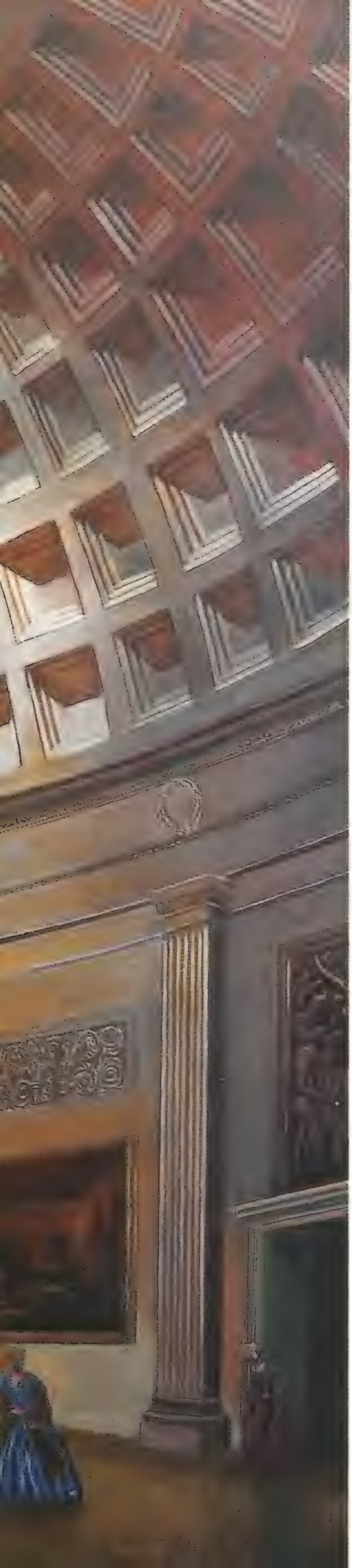
A recent baby boom on Codfish Island (above) produced 24 chicks (including the two below). Nestlings (bottom) receive regular checkups .

Is the kakapo worth all the fuss? Merton answers by citing the Chatham Islands black robin, once the rarest bird in the world, but now thriving in a self-sustainable population. "We absolutely must do the same for the kakapo, create a place and a situation where they don't need us anymore," he says. "If we can't save the kakapo—our flagship species and number one conservation priority—what hope is there for all the other, less glamourous critters?" Merton adds that he would be the happiest man alive if he were able to put himself out of a job.

Frequent contributor Derek Grzelewski writes from his home on the edge of Fiordland wilderness, a onetime kakapo stronghold.

Merton's bold plan calls for airlifting kakapos to a remote island between Antarctica and New Zealand.

GIDEON CLIMO (2); DON MERTON



Politically Correct

ARTIST PETER WADDELL'S SCRUPULOUSLY RESEARCHED PAINTINGS OF THE U.S. CAPITOL BRING HISTORY TO LIFE

BY DEIDRE STEIN GREBEN

"WHEN PEOPLE THINK OF THE U.S. CAPITOL," SAYS PETER WADDELL, "IT'S USUALLY AS A backdrop for some trench-coated newsman reporting live from its steps." Not Waddell; the New Zealand native has been in thrall with the building since his first visit to Washington, D.C. in 1991. "It was the middle of the winter," he says, "and everything was quiet and hushed. The stone, the marble, the sky—they were all silvery gray and bathed in this kind of strange, pearly light."

Since moving to Washington in 1995, Waddell, a 47-year-old artist specializing in historical subjects, has spent two and a half years creating 20 carefully researched paintings that vividly reconstruct the Capitol's interiors as they appeared from about 1812 to 1875. These works are now on view at the American Architectural Foundation's Octagon Museum in Washington (through October 15). "The building was a vital part of the social and cultural life in the city in the 19th century," says Waddell. "My interest was not in political subjects but in the lives of the people who built and visited the Capitol."

Author and historian David McCullough shares the artist's view of the Capitol's significance. "It's our most important building," he says. "It's our castle, it's our shrine, and Waddell has snapped it to life. Maybe only someone born elsewhere, with a different perspective, could remind us how wonderful it is."

McCullough believes that Waddell's somewhat fanciful renderings are more historically accurate even than photographs from the period. "There's a tendency to think of the Victorian era as dour, gloomy and overbearing, with morbid darks and lights," he says. "That's primarily due to our familiarity with 19th-century portraits, where no one smiles and the subjects had to hold still because of the slow shutter speed. That wasn't how people were then. Waddell has captured the spirit of those interiors. He shows them as colorful, rich and romantic—as a whole world unto itself."

Waddell's paintings invoke a time when men and women could wander

"I see the Capitol as a giant stage set," says Waddell (above with his painting of an 18th-century Georgian house). In *The Spirit of Washington*, 1842 (left), Horatio Greenough's statue of Washington holds court under the original Pantheon-like dome of the Rotunda.

Waddell's rendering of the Speaker's Office in 1861 was based on an 1860s photograph of the room in its "summer dress" striped slipcovers. His painting of Brumidi's Senate Naval Affairs Committee Room, c. 1856 (opposite), includes the original Minton tile floor.

freely through the Capitol's halls, chambers and vestibules—rooms in which a good deal more than government and politics took place. (Today visitors must be part of an official tour to see anything inside the Capitol and even then access is limited to a few major spaces such as the Rotunda.) The main attraction, then as now, were Congressional sessions, but in the early days visitors could also attend religious services, join in celebrations of national holidays, witness demonstrations of the latest scientific innovations or simply marvel at the building's grandeur. "I wanted to paint the rooms as they appeared when they were new," says Waddell, "and to show what they meant to the people who used them at the time."

Waddell, wrote *Washington Times* art critic Joanna Shaw-Eagle of the Octagon show, "has brought a romantic, even surrealist, sensibility to painting the historic buildings of Washington," and *Roll Call* critic John McArdle called the exhibition "a stunning and nostalgic glimpse of the places and stories that existed inside the Capitol building." *The Spirit of Washington, 1842*, for instance, shows the Rotunda capped by architect Charles Bulfinch's original wood-and-copper dome. Bonneted ladies wearing crinoline skirts waft through the grand atrium. Some of the women study the large historical paintings on the walls while others seem to avert their eyes from Horatio Greenough's controversial statue of a partially clad George Washington.

"The painting records a very specific period," says the Capitol's architectural historian, William Allen, noting that Greenough's sculpture, which depicted America's founding father as a Greek god, remained inside the Capitol for only two years before being banished to the building's east lawn. (The statue now resides in the National Museum of American History.) "It is the first color rendition of a room that hasn't looked that way since 1855," adds Allen.

A stickler for historical accuracy, Waddell based his paintings on written descriptions of the structure over the years, and on a handful of early prints, photographs and architectural plans. He gleaned most of the details for his depiction of the original dome and Rotunda from a sketch done in the 1830s by a New York architect. "Waddell takes the information, blows it up and completes it," says Allen.

To help the artist portray the original Library of Congress while it was being built around 1821 in the Capitol's center section just off the west portico, Allen referred Waddell to an old carpenter's handbook that showed the ceiling's wood-truss system (destroyed by fire in 1851). In the painting, amid laborers and engineers, scaffolding and brick, a winch hoists great sandstone pieces of the Corinthian columns—the Capitol's only columns not fashioned entirely of single blocks of stone. "It may be a little detail," says Allen, "but if he had shown it otherwise, it wouldn't have been right."

In one of his works, Waddell portrays B. Henry Latrobe, an early Capitol architect, giving a private tour to Madame Betsy Patterson Bonaparte in 1812. The notorious American beauty, who scandalized Washington society with her sheer, formfitting gowns, was then married to Napoléon's youngest brother, Jerome. (The marriage was later annulled by Napoléon.) Waddell portrays another historic personage, Samuel F.B. Morse, in the building's basement wiring up a telegraph demonstration for members of Congress. In the painting, Morse—also an accomplished artist—comes across an obviously neglected sculpture he had made 20 years earlier and presented to architect Charles Bulfinch.

In *Walt Whitman's Solace, 1865*, the poet emerges from the shadows of a doorway. Whitman helped minister to some of the more than 4,000 Union troops housed in the Capitol during the Civil War (many were injured or ill) and was initially troubled by the contrast between the ailing soldiers and the lavish decor—"poppy-show goddesses and all the pretty blue and gold," he described it. But he would also write that the opulence became a source of comfort to him.

"I think there is an element of shock when people see what the rooms looked like," says Waddell. "They're so decorated, gilded and ostentatious. It seems out of step with how Americans saw themselves." Consider his rendition of the Senate Naval Affairs Committee Room as it

PHOTOGRAPHY BY ROBERT C. LAUTMAN

"I am fascinated by the way things are made," says Waddell of his view of the c. 1821 construction of the Capitol's west portico and the original Library of Congress. Damaged twice by fire and in need of more space, the library moved across the street in 1897.

looked circa 1856. The Italian-born artist Constantino Brumidi painted the vividly colored murals—inspired by Pompeian frescoes—and American artist George R. West created naval scenes in lunettes above the doorways. But following a dispute about payment for the work, West's paintings were obliterated. Waddell has re-created one of the scenes in his rendering of the room, whose ornateness, according to Barbara Wolanin, curator for the Architect of the Capitol, caused quite a stir when the room was first opened for use in 1858. "All that elaborate painting, all those nymphs and cherubs, were considered outrageous at the time," she says. In his painting, Waddell has also restored the room's current green wall panels to their original blue and exposed the old Minton tile floor.

"Peter has brought bits of information together and made them become a reality," says Senate curator Diane Skvarla, who, along with Allen and Wolanin, assisted the artist in his research. "That's what makes the works exciting." Waddell even enlisted Skvarla to pose for one of his paintings. In *The Bather, 1869*, she appears as a tourist who accidentally walks in on a senator emerging from a marble bathtub in the building's basement. "It certainly made for a lot of conversation at the exhibition's opening," says Skvarla. When not in use, the tub, one of six made available to members of Congress whose living quarters lacked running water, was "always open to the inspection of visitors," according to an 1860s newspaper account.

Waddell, who grew up in Hastings, a small town on New Zealand's North Island, developed an early interest in history and architecture. "I used to like to climb up onto the roof of my house and look out," he says. "Everything was flat, except for the municipal theater, the public library and some banks with neoclassical facades." He was encouraged to pursue a career in the arts by his mother, Penny, a librarian and law clerk, and by his father, Colin, who owned a cabinetmaking business. "I grew up seeing things made from start to finish," he says.

Waddell studied fine art at the University of Canterbury in Christchurch. "The cutting edge had become very important in New Zealand," he recalls. "Unless it was for the purpose of sledgehammer irony, it was very daring to portray a person in a painting. Narrative and historical subjects were essentially forbidden—and those were the things that fascinated me most." As a young artist in Auckland, Waddell taught art at a local college and painted brightly colored figurative works using expressionistic brushwork.

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On warm summer evenings in the 1870s, the tall windows of the Marble Room, a private lounge just outside the Senate Chamber, were usually left open, allowing bats to gain entrance. Senate pages were assigned the challenging task of chasing them out.

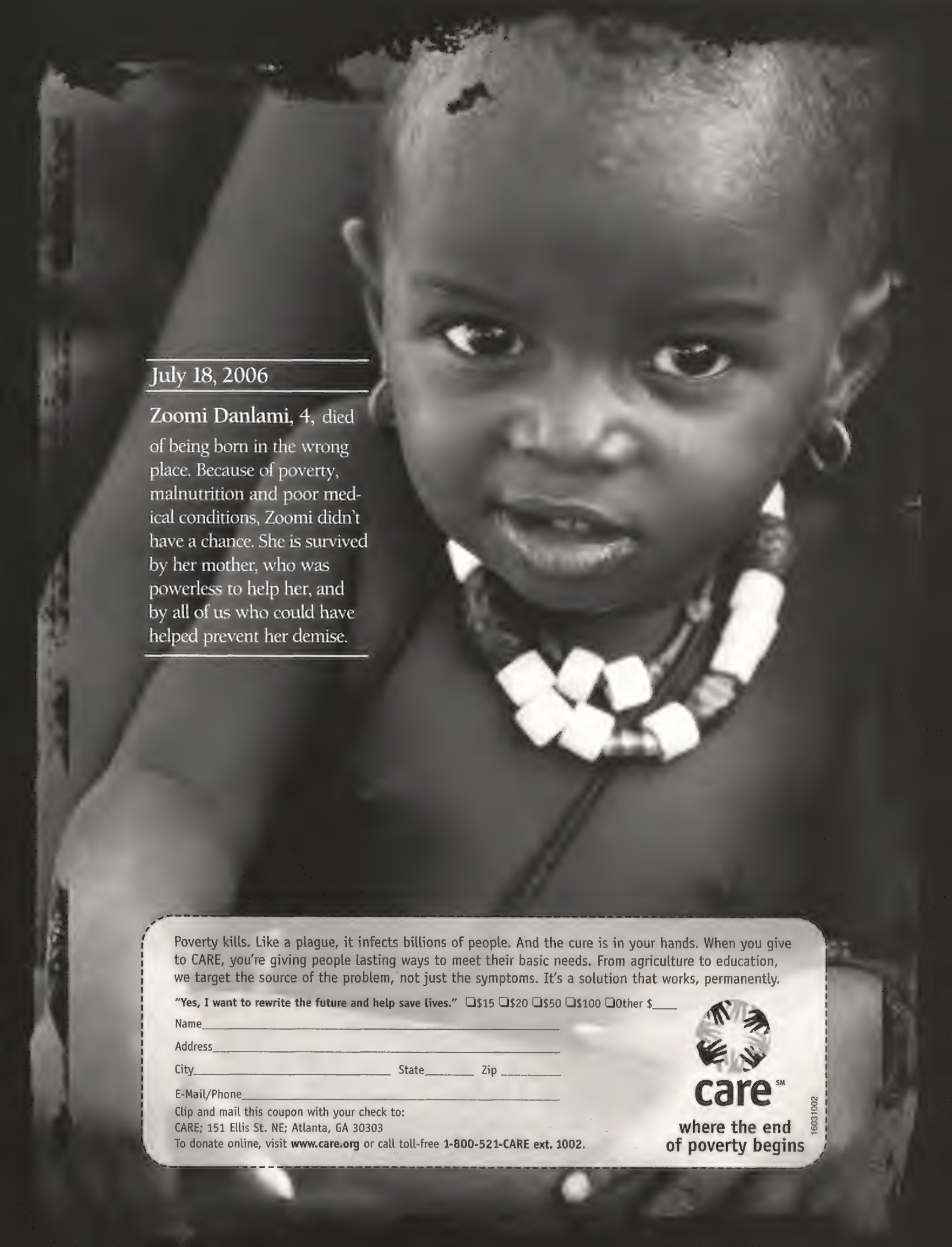
It wasn't until 1993, when a collector in Boston commissioned him to do a painting of Alexander the Great, that Waddell began introducing figures in period dress into architectural settings. "I started to make historical costumes for my models to wear," he says. "I always loved the photos of my great-grandmother in her bustles, hats and gloves."

These days, Waddell is the artist-in-residence at Tudor Place Historic House and Garden in Washington, designed by original Capitol architect William Thornton for Martha Custis Peter (granddaughter of Martha Washington) and her husband. "It's the perfect situation for me," says Waddell. "The estate was home to six generations of a family that never threw anything out. Every object tells a story about the people who lived there."

The Capitol has always been a place of low-down intrigue and ambition as well as lofty aspiration, but much of the appeal of Waddell's paintings lies in his depiction of a lost innocence. *The Marble Room—An Evening's Work, 1871* captures that nicely. Based on a detail taken from a historical chronicle by Senator Robert Byrd, it shows two young pages chasing bats out of the Senate lounge.

Yet Waddell's works, for all their charm, accommodate the view that history is not always picturesque. "One senator recently wanted to restore his office to its original appearance and was quite displeased when he found out that it had been an eight-seater privy," says Waddell. "The past is not always how you imagined."

The former managing editor of ARTnews, *New York-based freelance writer Deidre Stein Greben specializes in covering the arts.*



July 18, 2006

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CALIFORNIA SCHEMING

LOS ANGELES' INSATIABLE THIRST FOR WATER, WHICH DRAINED THE OWENS VALLEY, HAS RUINED LIVES, SHAPED THE CITY'S POLITICS AND PROVOKED ONGOING CONTROVERSY

BY MARK WHEELER

AT THE MOMENT, CHRIS PLAKOS IS A LITTLE EMBARRASSED. THE PUBLIC RELATIONS MANAGER for the Los Angeles Department of Water and Power is looking for a river he can't find. We're driving down a road 200 miles from Los Angeles, in the Owens Valley, which parallels the Sierra Nevada for about 100 miles. Plakos' employer owns most of this valley, having obtained it decades ago by means that may fairly be called ruthless. Plakos wants to show me how, these days, the municipal utility has become more enlightened toward the region and its residents.

We know the river is east of us, so it should be a simple matter of pointing the rented SUV in that direction. But we are caught in a whiteout caused not by snow but by salt, blowing off a dry lake bed to the south. The cloud contains microscopic particles of nickel, cadmium and arsenic, which at high doses have been shown to cause cancer in animals.

We keep the windows rolled up tight.

Plakos is also embarrassed because the salt-out is traceable to his employer's past policies, and the utility, in a historic turnaround after decades of hostility and acrimony, recently agreed to do something about the problem. So he doesn't need this possibly toxic atmospheric pollution just now. These dust storms, which have long plagued the area whenever the wind is just so, arise from Owens Lake. Once a shallow 110-square-mile body of briny water that still managed to support an abundance of grasses, birds and other wildlife, it was drained decades ago by L.A.'s seemingly bottomless demand for water, transforming the lake into a vast, dusty, cracked-white patch of high desert. It's the most visible casualty in the battle for the water that turned Los Angeles into a major metropolis—a battle about to be rejoined as the city eyes untapped water sources beneath the Mojave Desert.

Above, from left, c. 1905: J. B. Lippincott, of the Reclamation Bureau, Fred Eaton and William Mulholland. Left: The Alabama Gates were the site of a tense four-day occupation by protesters in 1924.

Once a shallow 110-square-mile body of water, dusty Owens Lake is today the most

Caused by the diversion of water to the city of Los Angeles, Owens Lake's dust storms are so large that the EPA considers them among the worst pollutants in the United States. The city is trying to remedy the problem by shallow-flooding the lake bed with water.

In the final analysis, it's not the balmy climate or the $31 billion a year the entertainment industry generates for the city that makes Los Angeles possible. It's water. Without it, the town one newcomer in the 1860s called a "vile little dump" (pop. 13,000) would never have evolved into the second most populous city in the United States.

L.A.'s 19th-century movers and shakers knew that the city's health and prosperity depended upon the availability of freshwater. Los Angeles sits on a semiarid coastal plain, with desert on three sides and the Pacific Ocean on the fourth. Freshwater was limited to the meager flow of the Los Angeles River, now a much-maligned concrete channel, and the paltry 15 inches of rain that the area averages a year.

THE SPIGOT FOR LOS ANGELES IS LOCATED NORTH OF Owens Lake and the small town of Independence, off US 395 and down a mile of bad road. It consists of nothing more than two 20-foot-long concrete blocks. Here, on the eastern slope of the Sierra 4,000 feet above sea level, the Owens River, which used to meander the valley's entire length before emptying into Owens Lake, smacks abruptly into a concrete barricade. Then it is directed to a man-made, arrow-straight dirt channel.

Roman Polanski's 1974 movie *Chinatown*, with Jack Nicholson, shaped the popular conception of the Owens Valley water war.

This is the gateway of the Los Angeles Aqueduct. Nearly a century ago an army of 5,000 men used dynamite, steam shovels, dredging machines and mules to dig out 233 miles of canals and tunnels. They carved the aqueduct out of unforgiving terrain, laying pipe across searing stretches of desert and going over, and often through, solid Sierra rock. Completed in 1913, the aqueduct still carries up to 315 million gallons of water a day to thirsty Angelenos.

You might think this engineering marvel worthy of notice. After all, it is largely responsible for the Southern California of today, as well as the ever-innovating city that has shaped so much of American life and world culture. But there's no roadside attraction here, no plaque, no visitors. Just wind, the gurgle of water and the occasional distant whine of a car speeding along US 395. The only marker is etched into one of the concrete walls: "A.D. MCMXI, LOS ANGELES AQUEDUCT INTAKE."

The low profile likely reflects the fact that as the aqueduct carried away the valley's water, it also carried away the local economy. It left Owens Valley farmers and ranchers high and dry. They responded with lawsuits, protests—and finally, dynamite of their own.

The Owens Valley water war has provoked impassioned debate and been the subject of numerous books. It also provided the backstory to the 1974 film *Chinatown*, which, though fiction, has contributed to the popular perception that Los Angeles raped the Owens Valley. Others contend that the area's economics were spiraling downward anyway and that California's future lay inevitably on its southern coast. The truth, as usual, is more complicated.

L. CLARKE/CORBIS; PHOTOFEST

visible casualty of the aqueduct that turned Los Angeles into a major metropolis.

TO BE SURE, A CRITICAL PART OF THE AQUEDUCT STORY IS the tale of wealthy Los Angeles businessmen speculating in real estate. They included Harrison Gray Otis and his son-in-law, Harry Chandler, owner and publisher, respectively, of the *Los Angeles Times*; E. H. Harriman, president of the Southern Pacific railroad; and Moses Sherman, a real estate developer and member of the city's water board, which established policy for this utility. Otis would use the *Times*' considerable influence to rally support for the aqueduct. Most historians believe that Otis and his colleagues engaged in shadowy dealings and traded on inside information, learning ahead of the public (probably from Sherman) where the aqueduct would terminate and where excess water would be stored—in the water table under the San Fernando Valley, adjacent to Los Angeles. All told, Otis and his colleagues bought 16,000 acres of this valley, which they later sold at a handsome profit.

But the main story of the greening of Los Angeles centers on two other men: William Mulholland and Frederick Eaton. Different as night and day, they were warm friends before becoming bitter enemies. Without their efforts, the aqueduct would not have been built; yet the project would prove to be each man's undoing.

An Irish immigrant, Mulholland was blunt-spoken, almost six feet tall with curly hair and a bushy mustache. He was in his 20s when he settled in L.A. in the late 1870s, after stints as a sailor, dry goods merchant and lumberjack. His first job in the city—at $1.50 per day—was as a deputy zanjero, or irrigation ditch tender, with the privately owned Los Angeles Water Company. But Mulholland was too ambitious to remain a zanjero for long. Teaching himself mathematics, hydraulics and geology, he became a hydraulic engineer within two years, foreman within eight, and then, at 31, superintendent, a position he retained after the city purchased the water company.

For some of that time his boss was Frederick Eaton, a Los Angeles native raised in a well-to-do family. In contrast to the rough-hewn Mulholland, Eaton was sophisticated and polished. He loved his native city, serving as superintendent and chief engineer of the L.A. Water Company and then, from 1898 to 1900, as mayor of L.A.

By 1900, L.A.'s population stood at 102,000, twice what it had been a mere decade earlier. By 1904, the figure had again nearly doubled. As the population rose, the water table began to drop. Some estimates suggested that the Los Angeles River would provide enough water for no more than 250,000 people. Both Eaton and Mulholland realized an entirely new source was needed.

Mulholland began looking throughout Southern California for an alternative supply of freshwater, but it was Fred Eaton who came up with a solution. On a camping trip to the Sierra in the early 1890s, Eaton had gazed down upon Owens Lake and thought about all the freshwater flowing into it and going to waste. Yes, Los Angeles was some 200 miles away, but *it was all downhill*. All one would have to do to move it to the city was dig some canals, lay some pipe and let gravity do the rest. Furthermore, he realized, several streams flowing out of the Sierra could be used to generate hydroelectric power. Imagine, a 200-plus-mile aqueduct running downhill to L.A. and "free" power to boot! Over the next two decades, as his civic interest joined his personal financial interests, Eaton grew increasingly evangelical about Owens Valley water.

In September 1904, he took Mulholland to Owens Valley with only "a mule team, a buckboard, and a demijohn of whiskey," Mulholland later recalled. Despite the hooch, it was the water and not the whiskey that made a believer out of Mulholland. He readily endorsed Eaton's proposal to build an aqueduct. Eaton, meanwhile, was buying water options from Owens Valley ranchers and farmers whose

P. 104 CHAD SLATTERY; P. 105 ANDREW A. FORBES/LOS ANGELES DEPARTMENT OF WATER & POWER

Newspapers reported that one out of five Angelenos turned out for the opening of the Los Angeles Aqueduct on November 5, 1913.

pastures bordered the river, without disclosing the city's plan. He also purchased a 23,000-acre cattle ranch in Long Valley, most of which he hoped to sell to the city, at a tidy profit, for use as an aqueduct reservoir.

Historians differ on Eaton's motives. Some say he duped Owens Valley residents. Others say his purchases, though cunning, were justifiable because they benefited the city, which lacked the money to buy the land until voters later approved a $1.5 million bond measure. To his dying day, Eaton denied charges that he acted duplicitously.

Grandson John Eaton, who until a year ago lived on one of the last acres of land in Long Valley passed down from his father, Harold Eaton, believes that his grandfather had no need to double-deal. "People were seeking him out to sell their property," he says. "They saw him as this crazy millionaire who wanted to become a cattle baron and who was foolishly overpaying for land. And they wanted to get out." It was a hardscrabble life, what with the valley's short growing season, and the playing out of local gold and silver mines, the market for its produce. Of course, had the sellers known the buyer in the shadows was the city of Los Angeles, they wouldn't have sold their land so cheaply, if at all.

In any event, when the ranchers and farmers learned the real story in 1905—"Titanic Project to Give the City a River" headlined the *Los Angeles Times* that July—they were so angry that Eaton had to leave town for awhile.

The construction of the aqueduct, under the direction of Mulholland, proceeded quickly. To provide power for electric shovels, he erected two hydroelectric plants—still in use today—on creeks that dump into the Owens River. He also built some 500 miles of roads, ran telephone and telegraph lines across 150 miles of desert, and laid down 268 miles of pipe to provide drinking water for the workers.

Conditions were harsh. Temperatures in the Mojave Desert could swing 80 degrees in a single day. "In the winter, it was just as windy and bitter cold as it was hot in summer," Raymond Taylor, the aqueduct's medical director, said at the time. Over the six years of construction on the aqueduct, 43 men died out of the 5,000 or so who worked on it, a toll that some experts say was rather low

S.A. SMYTH/CORBIS

An army of 5,000 men carved the aqueduct out of unforgiving terrain, laying pipe across searing desert and going over, and often through, Sierra rock.

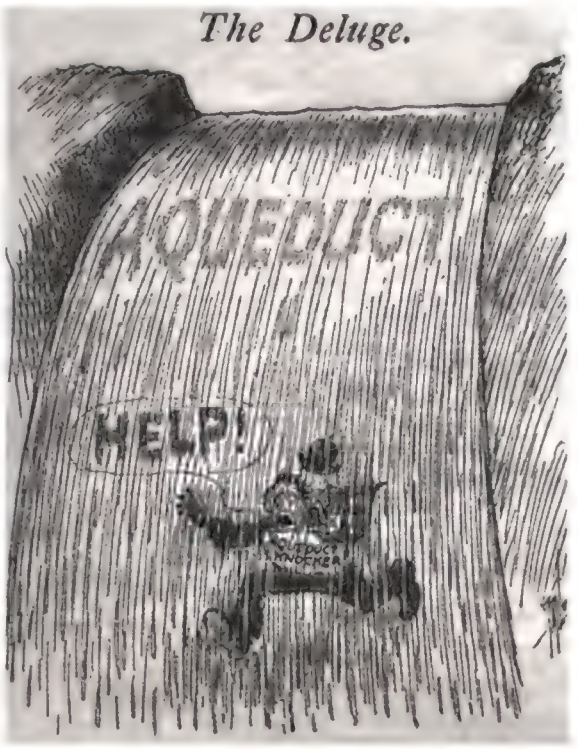
considering the scope of the project and the rugged terrain.

On November 5, 1913, Los Angeles officials staged a grand opening ceremony at the aqueduct's terminus in the San Fernando Valley, with parades, fireworks and speeches, including a famously terse one from Mulholland: "There it is," he said, as the gates opened, "take it."

Eaton did not attend. His years of dreams of a real estate empire had come to naught. Mulholland had balked at Eaton's price for the Long Valley land, which most historians peg at $1 million—and refused to pay it. Consequently, the completed aqueduct at first had no reservoir in the Long Valley area.

For a time, life in Owens Valley remained largely unaffected by the aqueduct. Most farming and ranching took place at the valley's northern end, above the aqueduct's intake point, so the river still provided plenty of water. Valley produce still found a market, however reduced, at local mines, many of which were still operating.

But things changed. People continued to pour into Los Angeles, and several years of drought in the 1920s slowed the aqueduct's flow. To compensate, the city began pumping groundwater directly from the aquifer beneath Owens Valley. Starved of water, local farms and ranches failed. Businesses followed. Some Owens Valley farmers sued Los Angeles and lost. Others began taking water directly from the aqueduct. The city countered by buying valley property in a checkerboard fashion—purchasing one farm but not the one next to it, which pitted neighbor against neighbor.



A 1913 cartoon reflects the view that the Eaton-Mulholland plan was unstoppable.

Owens Valley residents took matters into their own hands at 1:30 A.M. on May 21, 1924. A caravan of cars with about 40 men set out from Bishop, the largest town in Owens Valley, headed 60 miles south, and just north of Lone Pine, dynamited the aqueduct's concrete canal. Six months later, a number of Owens Valley residents, led by local banker Mark Watterson, seized the aqueduct's Alabama Gates spillway, near Lone Pine and opened its gates, sending the precious liquid back into the Owens River.

Mulholland was furious. He dispatched two carloads of gun-toting city detectives to break up the siege. Trying to prevent bloodshed, the Owens Valley sheriff warned them not to start trouble, saying, "I don't believe you will live to tell the tale." The detectives backed down. Soon local families arrived at the spillway, some bearing food; picnic blankets were spread and a huge barbecue ensued. Movie cowboy Tom Mix, shooting a film on location nearby, sent over his mariachi band to perform. The press arrived and took pictures. In the meantime, Watterson's brother, Wilfred, also a banker, went to L.A. and appeared before the Los Angeles Joint Clearinghouse Association, a group of bankers, asking for a new commission to negotiate city payments to the valley. When the bankers agreed, the siege ended peacefully.

But negotiations between the commission and Owens Valley locals, represented by the Wattersons, dragged on. In December 1924, Wilfred Watterson presented the commission with two invoices, one for $5.3 million in reparations to ranchers, the other for $12 million to purchase the remaining land in the valley. The commission refused to pay.

Tensions between city and valley grew. Litigation ensued, but stalled in the courts. The city bought more valley land, displacing farmers and ruining more local businesses. Finally, valley frustrations reached another boiling point. On May 20, 1927, several men detonated explosives outside Mojave, 100 miles north of L.A., destroying a part of the aqueduct. A few days later, more blasts rocked the aqueduct farther north and, on June 4, still another. A train filled with L.A. detectives armed with Winchester carbines was sent to guard the aqueduct.

Though the detectives had no legal right to do so, they placed Owens Valley under martial law. It didn't help. Over the next two months, seven more blasts occurred at sites along the aqueduct, from Mojave in the south to Bishop in the north, damaging pipes and a power plant and downing telegraph lines.

In the end, what broke the valley's spirit was malfeasance by two of its own. In August, the Watterson brothers (whose bank dominated the valley economy) were arrested for embezzlement; they were later convicted on 36 counts. Some said the brothers had merely been trying to stay afloat financially, and helping others stay afloat, by moving money from one business account to another, recording deposits never made and debits already paid. Their defenders pointed out that none of the money ever left Inyo County. The state's prosecuting attorney, an Owens Valley local and a friend of the brothers, was said to have cried while delivering his final argument. The Wattersons were

WILLIAM MULHOLLAND AND THE RISE OF LOS ANGELES BY CATHERINE MULHOLLAND, UNIVERSITY OF CALIFORNIA PRESS (AUGUST 2000)

On May 20, 1927, several men detonated explosives outside Mojave, a hundred miles north of Los Angeles, destroying a part of the aqueduct.

A few ranches and farms still exist in the Owens Valley, but most (such as this homestead near Bishop) had to be abandoned due to a lack of water.

sentenced to ten years in San Quentin and their five banks closed. Posted on the door of one was the message: "This result has been brought about by the last four years of destructive work carried on by the city of Los Angeles."

Fred Eaton, whose plan to sell his Long Valley ranch was stymied by the city, now had worse problems. His son Harold had mortgaged it to the Wattersons' bank in loans totaling $320,000. When the bank failed, the ranch went into receivership and the city purchased it—for less than the $500,000 Mulholland had offered ten years earlier.

Eaton died in 1934 at age 78, his dreams of fortune unfulfilled. "He was bitter," says his grandson John Eaton, "because he felt he'd been made the goat for all the troubles that came to ail the Owens Valley, and because he felt he never got the proper credit for his role in the creation of the aqueduct."

Mulholland, for his part, died a chastened man at 79, a year after Eaton's death. A dam that Mulholland had built in San Francisquito Canyon, outside Los Angeles, collapsed in 1928, less than 12 hours after he had inspected it and pronounced it sound. A wall of water 100 feet high roared down the canyon, sweeping away trees, homes, cars, a railroad trestle and animals, and killing at least 400 people. Mulholland, although cleared of wrongdoing, blamed himself. He soon retired from the water department and became a virtual recluse, a "stooped and silent" old man, Catherine, his granddaughter, says. (In the 1990s, David Rogers, a forensic geologist who studied the dam rupture, concluded that while there were some flaws in the construction, it was a massive landslide that felled the dam.)

Today most of the people residing in the Owens Valley make their living from tourism, with the majority of skiers, fishermen, campers and so on coming from (where else?) Los Angeles. Some ranches and farms still exist, but most of their fields are leased from the L.A. Department of Water and Power. The bulk of Owens Valley land is empty, its former vitality reduced to groupings of shade trees where houses once stood; long, V-shaped ditches, once used to water fields, now dusty and weed choked; an occasional concrete silo surrounded by sagebrush.

The aqueduct was extended north another 100 miles in the 1940s, to a second large body of water, Mono Lake. Another entire aqueduct was built in 1970 alongside Mulholland's. Almost 100 years have passed since William Mulholland ruled the roost, but for L.A.'s Department of Water and Power engineers, the mandate is still the same: keep the water coming.

I'M STANDING SOMEWHERE IN THE MIDDLE OF OWENS Lake—white, cracked, powder-dry and stretching off in every direction—with Ted Schade, an engineer and senior project manager for a tiny regional agency, the Great Basin Unified Air Pollution Control District. The agency is responsible for enforcing the federal Clean Air Act in Owens Valley, and thanks largely to it, things here are looking up.

Right now, the wind is still, and it's OK to breathe. Yesterday, upwind and north of the lake, I saw a huge white cloud boiling off the lake bed. According to the Environmental Protection Agency, when the wind blows, this lake is the single largest source of particulate matter pollution in the United States.

Schade's agency has been David to the Los Angeles utility's Goliath since the mid-1980s, when the city, responding to a California state law, was required to pay several million dollars a year to monitor the air and figure out how best to stop the pollution (which meant, in effect, that the city paid the salaries of its antagonists). In 1997, Schade's group approved a plan that ordered the city to flood the dry lake bed with water or grow a salt-tolerant grass.

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Ted Schade (overlooking Owens Lake) says L.A.'s water wars are here to stay; Cadiz's proposal to store water under land (left) it owns in the Mojave Desert has brought out some vocal opponents.

Where the water came from was up to the city, but of course, the only readily available water was from the aqueduct. "The city just went crazy," says Schade. "They filed a lawsuit, tried to withhold money, and appealed the plan to the state of California."

Then the utility's new general manager, S. David Freeman (now California Governor Gray Davis' energy czar), called a truce. "He just said what the city was doing was wrong," says Schade, "and within a couple of weeks we had an agreement." Grudgingly, the city agreed to have ten square miles of dust control measures in place by 2001, with incremental improvements after that.

By November 2001, diversion of some of the aqueduct's precious water had begun; by January 2002, more than 7,600 acres of dusty Owens Lake bed had been submerged in a few inches of water. But more remains to be done. In other sections of the lake bed, the city is currently planting more than 2,600 acres with hardy native grass that tolerates high salt and both freezing and blistering temperatures. The project is scheduled to be complete by 2006, by which time Los Angeles should have implemented dust control measures on more than 14,000 acres of Owens Lake bed, using about 50,000 acre-feet of water a year, enough to supply almost a quarter of a million people.

If water politics in Southern California today are no longer as rough-and-tumble as in Mulholland's era, controversy continues to surround the struggle to meet the demand for water in the fast-growing region.

In one recent flap, water officials representing the greater Los Angeles area have struck a preliminary agreement with a private firm that owns large parcels of the Mojave Desert and controls access to an aquifer there. The firm, Cadiz Inc., proposes to service Southern California by pumping water out of the aquifer as well as using it to store water diverted from the Colorado River. The project, though approved by the Department of the Interior, still faces opposition from California Senator Dianne Feinstein and some environmentalists. In stating their concerns that drawing water from the aquifer will damage the fragile desert ecosystem, opponents also note that the aquifer runs under two dry lakes, and specifically cited what happened to Owens Lake as an example of what could go wrong.

Maybe that will be Owens Lake's legacy, says Schade: an object lesson for what not to do. "Hopefully, everyone has learned from the mistakes that were made here."

Los Angeles-based freelancer Mark Wheeler wrote last for SMITHSONIAN *about volcanic unrest in California's Long Valley.*

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As humans fall behind in the battle against antibiotic-resistant bacteria, the race for new weapons turns to frogs and dragons

The Komodo dragon kills by infecting its prey with the deadly bacteria in its thick, sticky saliva. Researchers hope the saliva, which somehow protects the dragon from the germs, will lead to a new way to fight antibiotic-resistant bacteria.

"Drug-resistant bacteria represent one of the greatest threats to our species," says ethnobotanist Mark Plotkin, president of the Amazon Conservation Team, which works with people in the Amazon region to conserve forests and culture. Coauthor Michael Shnayerson, a contributing editor at Vanity Fair, *agrees. "People have no idea what bacterial dangers await them when they go to a hospital," he says. In a new book* Killers Within: The Deadly Rise of Drug-Resistant Bacteria, *Shnayerson and Plotkin report medical researchers' evidence that the number of disease-causing bacteria able to fend off the most commonly prescribed antibiotics has grown significantly. We live in a "grim new era" of superbugs, say the authors, who cite scientific studies suggesting that we have only ourselves to blame. Physicians who prescribe antibiotics when the medications are not necessary, patients who don't complete antibiotic treatments, and ranchers who overuse antibiotics to spur livestock growth have all contributed to the development of extra-hardy bacteria strains—a microbial world acting out the old saying that what doesn't kill you makes you stronger. The toll is huge. Public health experts estimate that infections from antibiotic-resistant bacteria kill some 40,000 Americans annually.* Killers Within *highlights efforts by experts to curb the problem and to develop new antimicrobial medications. In the excerpt that follows, scientists research powerful natural substances that some animals secrete to fight off infection—substances that may lead to the antibiotics of the future.*

Supergerm Warfare

THE FIRST TIME HE STALKED A DRAGON, IN November 1995, Terry Fredeking was scared. Bad enough to have flown all the way to Indonesia, deal with notoriously difficult Indonesian bureaucrats, brave the stifling heat, and find a local boat owner willing to whisk the biologist and two colleagues over to the sparsely inhabited island of Komodo. Worse, much worse, to lie in wait, awash with sweat, for the world's largest lizard to emerge from the forest in a hungry mood. That first time, Fredeking watched a Komodo dragon attack a goat. The Komodo was at least eight feet long and weighed well over 200 pounds. It looked like a dinosaur, Fredeking thought, it really did. It was almost all scales, with a huge mouth of large, curved teeth. One second it was lying in wait, all but invisible. The next, it was ripping out the terrified goat's stomach with a single bite. As it did, thick saliva dripped from the dragon's mouth, mixing with the blood and guts of the goat. Ah, yes, the saliva, thought Fredeking as he and his colleagues advanced from the bushes, tremulously holding long forked sticks. The saliva was why they were here.

Staphylococcus aureus is resistant to many antibiotics.

With luck, the dragon's viscous, revolting drool would contain a natural antibiotic that in some synthesized form could fight multidrug-resistant *Staphylococcus aureus*, which causes sometimes fatal blood poisoning, and other bacterial pathogens. At the least, Fredeking, a genial, stocky, self-styled Indiana Jones from Hurst, Texas, would have the adventure of his life and possibly contribute to the fascinating new field of animal peptides. It sure beat collecting bat spit in Mexico and harvesting giant Amazonian leeches in French Guiana.

This latest approach to antibiotic discovery traced in

Adapted from *The Killers Within*, by Michael Shnayerson and Mark J. Plotkin © 2002. Reprinted by permission of Little, Brown and Company.

large part to a well-ordered lab at the National Institutes of Health. On a fragrant, early summer day in June 1986, a mild-mannered M.D. and research scientist named Michael Zasloff had noticed something decidedly odd about his African clawed frogs. As chief of human genetics at a branch of the NIH, Zasloff was studying the frogs' eggs to see what they could teach him about the flow of genetic information from the nucleus of a cell to the cytoplasm. He would inject genes into the eggs, then see what happened. The frogs just happened to have large, good eggs for this purpose; their own biology was irrelevant to his work.

Terry Fredeking believes peptides may hold the key.

Some lab scientists killed the frogs after cutting them open to remove their eggs. Not Zasloff. He would stitch them up crudely—he was a pediatrician, not a surgeon—and when enough of them accumulated in a murky tank in his lab, he would secretly take them to a nearby stream and let them go. On this particular day, Zasloff noticed that the tank appeared to have "something bad" in it, because several frogs had died overnight and were putrefying. But some of the frogs he'd operated on, sutured and thrown back into the tank appeared fine. Why was that? Certainly the frogs' stitches were not tight enough to prevent bacteria and other microbes from infiltrating their bloodstreams. Yet no infection occurred. No inflammation, either.

This was, as Zasloff put it later, his "eureka" moment, for even as he asked himself the question, he intuited the answer: the surviving frogs must have generated some substance that afforded them natural antibiotic protection. (Zasloff never did figure out why the dead frogs hadn't done the same, but he suspected that their immune systems had been too compromised to help save them.) No likely suspects appeared under a microscope, so Zasloff began grinding samples of frog skin and isolating its elements. After two months, he still couldn't see what he was after. He could identify it, however, by its activity. He was dealing with two kinds of short amino acid chains called peptides—like proteins, but smaller. Scientists knew that peptides participated in many metabolic functions of living organisms, either as hormones or other compounds. They didn't know what Zasloff had just realized: that some peptides in frogs worked as antibiotics. Zasloff named them *magainins*—the Hebrew word for "shields"—and theorized that they might lead to a whole new class of human-use antibiotics. So promising was Zasloff's finding that when it was published a year later, the *New York Times* devoted an editorial to it, comparing Zasloff to Alexander Fleming, the British discoverer of the antibiotic properties of a fungus called *Pencillium*. "If only part of their laboratory promise is fulfilled," the *Times* opined of his peptides, "Dr. Zasloff will have produced a fine successor to penicillin."

Like Fleming, Zasloff had made his discovery through serendipity. It was a means about to become quaint. Soon genomics would begin to transform drug discovery into a high-speed, systematic search with state-of-the-art tools

No likely suspects appeared, so Zasloff began grinding samples of frog skin and isolating its elements.

The African clawed frog has its own immunities against bacterial infection.

JEFF WERNER/INCREDIBLE FEATURES; TOM BRAKEFIELD/CORBIS; P. 114 JIM KERN; JEFF WERNER/INCREDIBLE FEATURES; P. 115 DR. KARI LOUNATMAA/PHOTO RESEARCHERS

that analyzed bacterial DNA—the very antithesis of serendipity. But targeting individual genes, by definition, would yield narrow-spectrum drugs. No doctor wanted to rely exclusively on narrow-spectrum drugs, especially in the hours before a patient's culture was analyzed at the lab. Besides, a drug designed to hit one bacterial gene might soon provoke a target-changing mutation. Whole new kinds of broad-spectrum antibiotics were needed, too, and the best of those seemed less likely to be found by genomics than by eureka moments like Fleming's and Zasloff's, when a different approach presented itself as suddenly and clearly as a door opening into a new room. To date, virtually all antibiotics with any basis in nature had been found in soil bacteria or fungi. The prospect of human antibiotics from an animal substance suggested a very large room indeed.

The world had changed a lot since Fleming had published his observation about a *Penicillium* fungus, then basically forgot about it for more than a decade. Now biotech venture capitalists scanned the medical journals for finds that might be the next billion-dollar molecule. Zasloff would find himself swept from his NIH lab into the chairmanship of a new public company with Wall Street money and Wall Street expectations, his magainins hyped as the Next New Thing. Nearly $100 million later, he would also be the tragic hero of a cautionary tale about the challenges a maverick faced in bringing new antibiotics to market.

Antibiotic-resistant microbes (like *S. aureus*) kill an estimated 40,000 Americans each year.

AS HE MONITORED THEIR ACTION, ZASLOFF DISCOVERED that the peptides he called magainins act not by targeting a bacterial protein, as nearly all modern antibiotics do, but by punching their way through the bacterial cell's membrane and forming ion channels that let water and other substances flow in. These, in turn, burst the bacterium. This bursting or lysing occurred because the magainins were positively charged and the bacteria had negatively charged elements called phospholipids on their membrane walls. The positively charged peptides homed in on the negatively charged cell membrane as if piercing an armored shell.

The wall-punching mechanism suggested that peptides might be especially useful against *resistant* bacteria. The proteins targeted by nearly all existing antibiotics could be changed or replaced. For a bacterium to change its whole membrane would be orders of magnitude more difficult. It seemed impossible. And as far as Zasloff could see, peptides were drawn only to bacterial cell walls—never, in vitro at least, to the membranes of normal human cells. Which made them a perfect antibiotic.

Another NIH scientist might have published his findings, as Zasloff did, and gone back to tinkering in his lab with the next intellectual challenge. But as a pediatrician, remembering babies with cystic fibrosis, Zasloff wanted to see peptides turned into drugs *right away*. His first step was to call the Food and Drug Administration. "I'm from the NIH and I just made a discovery that's about to be published," he told the bureaucrat he reached. "Can I get someone from the FDA to help me do what I have to do to make this into a drug?" The FDA had no system, it turned out, to help government researchers develop drugs while keeping their government jobs. Nor did the NIH have any such guidelines. (Not long after, the agency would allow researchers to profit in modest ways from technology transfer, but the burgeoning biotech industry would be filled with NIH refugees wanting a larger share of the proceeds of their discoveries.) Zasloff risked being fired or sued, he discovered, simply for fielding the calls that began to pour in after his article was published. If he talked to Merck, he could be sued by Bristol-Myers, because he was a government official obligated to favor no company over another.

A call from venture capitalist Wally Steinberg decided his future. Steinberg offered Zasloff a deal that allowed him to help with the start-up—to be called Magainin—to teach, and to continue to practice as a pediatrician. In short order, Zasloff became a professor of genetics and pediatrics, in an endowed chair, at the University of Pennsylvania, and chief of human genetics at Philadelphia's Children's Hospital. For Magainin, set up outside Philadelphia in a corporate park of former farm town Plymouth Meeting, he worked as a part-time consultant.

It should have been an ideal setup, a dream life guaranteed to make any medical researcher sick with envy. But while Zasloff had thought he could work on peptides in his hospital lab and pass the results on to Magainin, the hospital's directors thought not. Work funded by the hospital, they declared, ought to remain the hospital's intellectual property. When the university, the third leg of Zas-

CHASSENET/PHOTO RESEARCHERS

loff's new career, began lobbying for its own share of the proceeds, Zasloff gave up. Heartsick, he resigned a directorship at the hospital, and gave back the endowed chair to the university. As of 1992, he would gamble his entire career on Magainin.

Since peptides seemed to work against almost anything, Zasloff and his colleagues scanned the market for a condition treated by only one drug: less competition, more opportunity. They settled on impetigo, the mild skin infection characterized by rashlike lesions, and caused by skin bacteria, usually certain streptococci or *S. aureus*. If the peptides worked as well or better than Bactroban, the existing treatment, they'd be approved. From there, Magainin could go on to test peptides against more serious topical infections, have a couple of profit-making products on the market, and so gird up for serious bloodstream infections.

The peptides sailed through phase one trials: applied to healthy human skin, they caused no harm. In phase two, they seemed to produce good results on 45 people who actually had impetigo. The Bactroban trials had involved a placebo: simple soap and water. Magainin followed suit. But when the results of the phase three trials were compiled in mid-1993, Zasloff was stunned. Though the peptides had done as well as Bactroban, neither product had done as well as soap and water! How, then, had Bactroban won approval in the first place? Zasloff never learned. The FDA merely announced that peptides had failed to do better than Bactroban. Overnight, Magainin's stock plunged from $18 to $3 a share. As Magainin teetered on the verge of collapse, Zasloff pulled a rabbit out of his hat. Or rather, a dogfish shark.

Overuse of antibiotics is making microbes (like *Enterococcus*, top, and *Streptococcus pneumoniae*, above) more lethal.

BY 1993, INSPIRED BY ZASLOFF'S ORIGINAL PAPER, DOZENS of other scientists had gone in search of peptides in other animals. They'd found them just about everywhere they'd looked—70 different antibiotic peptides in all—in everything from insects to cows to Komodo dragons. Intriguingly, different creatures secreted peptides from different kinds of cells. Many insects made them in their white blood cells. In horseshoe crabs, they appeared in the blood elements called platelets. In the frog, as Zasloff had determined, they appeared in a part of the nervous system called the granular glands: the frog empties these glands, Zasloff found, when the animal is stressed, or when the skin is torn. As for humans, they turned out to harbor peptides of their own: in white blood cells, in the gut and, notably for cystic fibrosis babies, in certain cells of the airway called the ciliated epithelium. Perhaps, thought Zasloff, some other animal's peptides would make a more potent antibiotic than those of the African clawed frog—potent enough to bring investors scurrying back to Magainin.

One day Zasloff gave his standard stump talk about peptides to a group of scientists at the Marine Biological Laboratory in Mount Desert, Maine. John Forrest, a professor at Yale University's medical school, raised his hand to say that he'd spent 19 summers studying the dogfish shark, and, by God, if the African clawed frog had peptides, so must the shark. The shark had long been Forrest's experimental animal model, as the frog was Zasloff's. Small and hardy, the shark had large, simple cells and organs that made it easy to study. Best of all, when Forrest operated on a dogfish shark, he could suture it up and toss it back in a tank of dirty water, as Zasloff did with his frogs. Inevitably, the shark healed without infection. Zasloff went home with a shark stomach expecting to find peptides. Instead, he found a new kind of steroid with even stronger antibacterial action—yet another element of the innate immune system. He called it squalamine. "Hey!" he told Forrest by phone. "Send me more of those shark stomachs!"

Eventually, Zasloff found a way to purify shark squalamine, and switched to livers, because a commercial fishery called Seatrade in New Hampshire could Federal Express him half a ton of them a week. Zasloff himself would wheel the heavy boxes of stinking shark organs in from the loading dock, then start slinging them into a giant meat grinder. The purification process involved heating the ground livers in garbage cans like great vats of soup, skimming the squalamine-rich scum from the top, then filtering the scum through a high-tech set of steps.

Along with squalamines, Zasloff found other steroids in the purified gunk. He figured there were more than 12 kinds in all. Each had broad antibiotic effects, but each also seemed to target a specific kind of cell in the shark's body. Publication of the discovery of squalamines had brought calls from around the world, and these helped focus Zas-

DR. KARI LOUNATMAA/PHOTO RESEARCHERS; GARY D. GAUGLER

loff's study. Several of the steroids worked as anticancer agents both in dogfish sharks and in humans. One kind even prevented lymphocytes from carrying out the AIDS virus' orders to make more virus.

Certain that he had found a way to save his company, Zasloff contacted Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases at NIH and, as such, the top U.S. government official involved in fighting AIDS. Fauci established a Cooperative Research and Development Agreement, or CRADA, with Magainin, and Zasloff started injecting squalamines into AIDS-infected mice and dogs and monkeys. The squalamines worked brilliantly—up to a point. They stopped the growth of the lymphocytes, just as they had in laboratory experiments. Unfortunately, as soon as the treated animals were hit with the squalamines, they stopped eating and began to lose weight.

For months, Zasloff struggled to solve the dilemma. A lonely figure reeking of shark liver, he spent his days skimming scum and injecting steroids into AIDS-infected lab animals. No approach worked. The animals' lymphocytes stopped growing, as did the AIDS virus, but the animals simply would not eat. Anthony Fauci gave up hope: the prospect of halting a patient's AIDS infection while having him die of starvation was obviously unacceptable.

Okay, Zasloff declared at last, *Okay*. All was not lost. "What nature has given us," he announced to his devastated colleagues, "is *an appetite suppressant*."

Zasloff discovered that frogs had intriguing immunities.

ZASLOFF HAD TWO STRIKES AGAINST HIM, and as far as his backers were concerned, it was the bottom of the ninth. But by the mid-1990s, the sharp rise in resistance around the globe had cast peptides, his other finding, in a more favorable light. Peptides still appeared utterly impervious to all the new mechanisms of resistance that bacteria had employed. Intrigued, the FDA offered to let Magainin try peptides once more, this time on a more serious topical condition than impetigo: infected diabetic ulcers. As the FDA knew, the existing antibiotics used against these painful foot lesions caused such debilitating side effects that patients usually stopped taking them—even though the lesions, when infected, tended to invade muscle and bone, and even led to amputation of the affected limb. Now, in addition, resistance to these antibiotics was rising. Worse, the most promising of them, Trovan, would soon be pulled from the market for causing liver toxicity. Here was a real need—and market niche—that peptides seemed perfect to fill.

Because patients could suffer irreversible harm from diabetic ulcers, the FDA ruled that no placebo would be needed. Zasloff's peptides merely had to do as well or better than one of the comparators, a powerful antibiotic called ofloxacin, which came not as a topical ointment but in oral form. Magainin breezed through phase one trials: the peptides, as shown in the previous trials, caused no harm to the skin of healthy people. To speed the process, the FDA

Steroids derived from dogfish sharks have debilitating side effects for humans.

Zasloff would wheel the heavy boxes of stinking shark organs in from the loading dock, then start slinging them into a meat grinder.

DR. MICHAEL A. ZASLOFF COLLECTION; DOUGLAS P. WILSON/FRANK LANE PICTURE AGENCY/CORBIS

let Magainin combine the next two phases. Roughly 1,000 patients were recruited from more than 50 medical centers in the United States between 1995 and 1998. These were very sick patients, their lesions excruciatingly painful. When doctors swabbed the lesions with a peptide solution, most of the patients seemed to improve.

As Zasloff pored over the final results, he felt encouraged, if not wildly optimistic. The topical peptides had not quite outperformed oral ofloxacin, but they'd done nearly as well. Certainly the tests had shown that MSI-78, as Magainin's latest peptide was known, had a broad and powerful spectrum, did not provoke resistance, and had no direct side effects. The results were strong enough for SmithKline Beecham to sign on as a partner. SKB would market the product as Locilex. Now all Magainin needed was formal approval by an FDA advisory panel.

The panel, comprised of seven experts from various fields, met on March 4, 1999, in Silver Spring, Maryland, to spend the whole day debating the merits of Locilex. Zasloff, looking on from the audience of 300, thought the morning session went well, but the afternoon was a different story.

Perhaps the panel members were served an inedible lunch. Perhaps the meeting room was too hot or cold. Whatever the reason, the members reconvened in a grumpy mood. One of the seven declared that in her opinion—founded not on clinical experience, only on the morning's 30-minute tutorial—no antibiotics were needed for infected diabetic ulcers. "Just cut the infected tissue out and throw it in the garbage can," she declared. One after another of the members agreed. The panel's chairman, Dr. William Craig, pointedly disagreed. Nevertheless, the vote was 7-5 not to approve the drug, a decision upheld formally by the FDA some months later. Michael Zasloff's 13-year crusade to use peptides against drug-resistant bacteria was finished.

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Over the next two years, Zasloff himself came to wonder if animal peptides would ever work in people. Perhaps the way to go was to focus on human peptides—plenty of those had been found—and to try to strengthen the barrier of innate immunity to fight human infections.

In a desperate bid to keep his company alive, Zasloff pushed squalamine into clinical trials as an appetite suppressant. He was serious. It was the Hail Mary play, as he put it, that might save the day. But no one else seemed to believe he could pull it off.

In the fall of 2000, Zasloff's own directors lost faith. The scientist whose discovery had inspired the company was made a consultant—pushed out, as Zasloff later admitted—and the corporate direction changed. The clinical tests with squalamine as an appetite suppressant were carried on: the stuff did look promising, wacky as the route to its application may have been. Early results had shown squalamine to be effective, as well, against ovarian and non-small-cell lung cancer. But in corporate press releases, no further mention was made of antibiotics—or peptides. From now on, the company would use genomics to find new targets and new natural substances like hormones as drugs. To make that perfectly clear, the name Magainin was changed to Genaera.

In his more contemplative moments, Zasloff admitted he'd made mistakes. But he had no regrets about his role in establishing a burgeoning new field: some 3,000 articles on peptides had been written since his seminal paper of 1987, some 500 peptides discovered. The innate immune system was now part of science. And for Zasloff, the most promising aspect of peptides was still their potency against resistant bacteria. They'd persisted through most, if not all, of evolutionary history. In all that time, bacteria had never become resistant to them. Was it too much to suggest that they constituted the Achilles' heel of pathogens? That bacteria never *would* become resistant to peptides? "They've had a billion years to fend these things off," Zasloff said, "and this is what we've got."

AS THE PRESIDENT OF ANTIBODY SYSTEMS, a small, Texas-based biotech company, Terry Fredeking had dedicated himself to the search for peptides and other natural substances in animals, the more exotic the better, that might lead to drugs for resistant pathogens. Michael Zasloff's discovery had made his work possible; one of Zasloff's former students was in his employ. Some of his samples—which included para-

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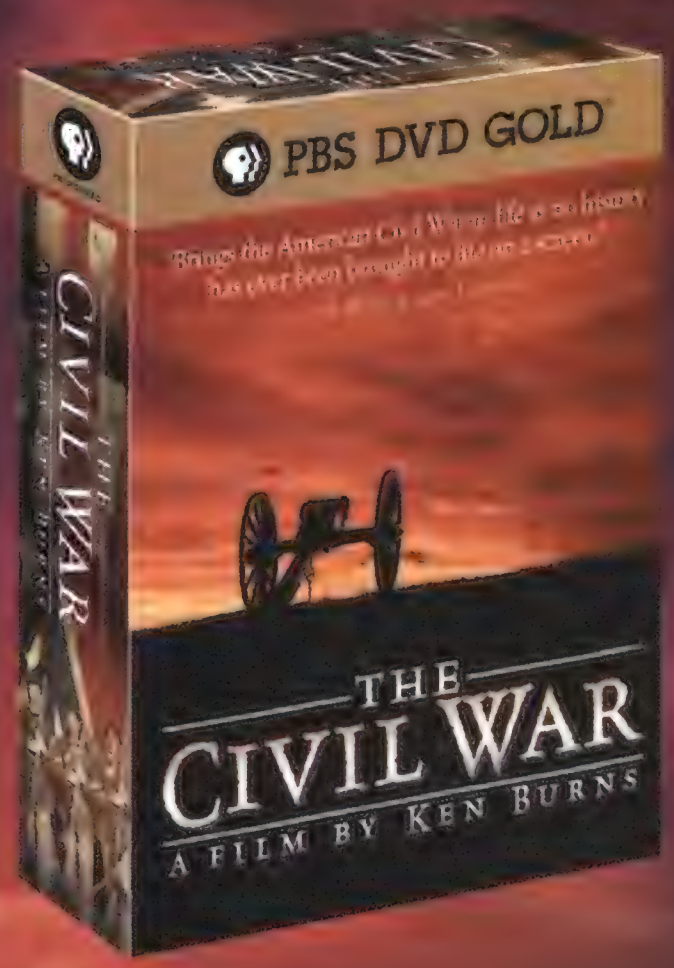

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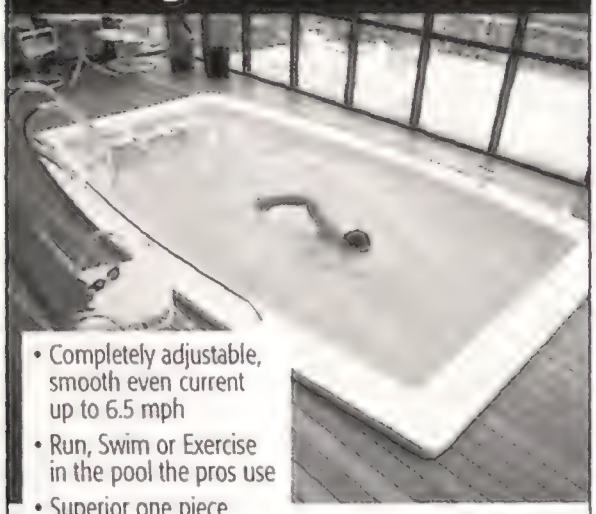

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sites from Tasmanian devils, among other odd things—showed promise in vitro, but Fredeking hungered for more. In truth, he was a bit of a showboater, eager to make his name, with the sort of chutzpah that made lab scientists shudder but sometimes got things done. "There's got to be something bigger than this," he said one day to one of his consultants, George Stewart, professor of parasitology and immunology at the University of Texas. "What can we do next that's dangerous, exciting and will advance science?"

"How about Komodo dragons?" Stewart suggested.

"Komodo dragons?" Fredeking echoed. "What in the heck are they?"

Stewart explained that the world's largest lizard, formally known as *Varanus komodoensis*, was justly famous for being one of a handful of predators big and fearless enough to prey on human beings on a somewhat regular basis. In fact, humans were by no means its largest prey: full-grown Komodos were known to bring down 2,000-pound water buffalo. Found only on the Indonesian islands of Komodo, Flores and Rinca, the dragons were descendants of mososaurs, massive aquatic reptiles that roamed the seas 100 million years ago. Though the Komodo dragon did often hunt down and devour its prey, it also had a craftier method of killing that hinted at the presence of antibiotic peptides. A stealth hunter, the dragon lay in wait for sambar deer, crab-eating macaque monkeys and other mammals of its habitat, then lunged for the abdomen of its passing prey with toothy jaws as strong as a crocodile's. Almost always, its wounded victims escaped, because the dragons, many of them heavier than a fat, six-foot-tall man, could run only in short bursts. But because the dragons often feasted on rotting carcasses, their jaws teemed with virulent bacteria. Within 72 hours of being bitten by the great lizard, animals would

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die of bloodstream infections brought on by these bacteria. Eventually the dragon would come lumbering over to take his meal at last.

Both because of its lethal saliva, and because the dragon ate carrion teeming with more bacteria, zoologists had long wondered what made the dragons immune to all these pathogens. Whatever it was had to be really powerful, because of an evolutionary oddity about the dragon's teeth. Razor-sharp as they were, and serrated like a shark's, the dragon's teeth were actually covered by its gums. When it snapped its jaws shut on its prey, the teeth cut through the gums. The dragon's lethal saliva, then, had access to its bloodstream. Yet the Komodo remained uninfected.

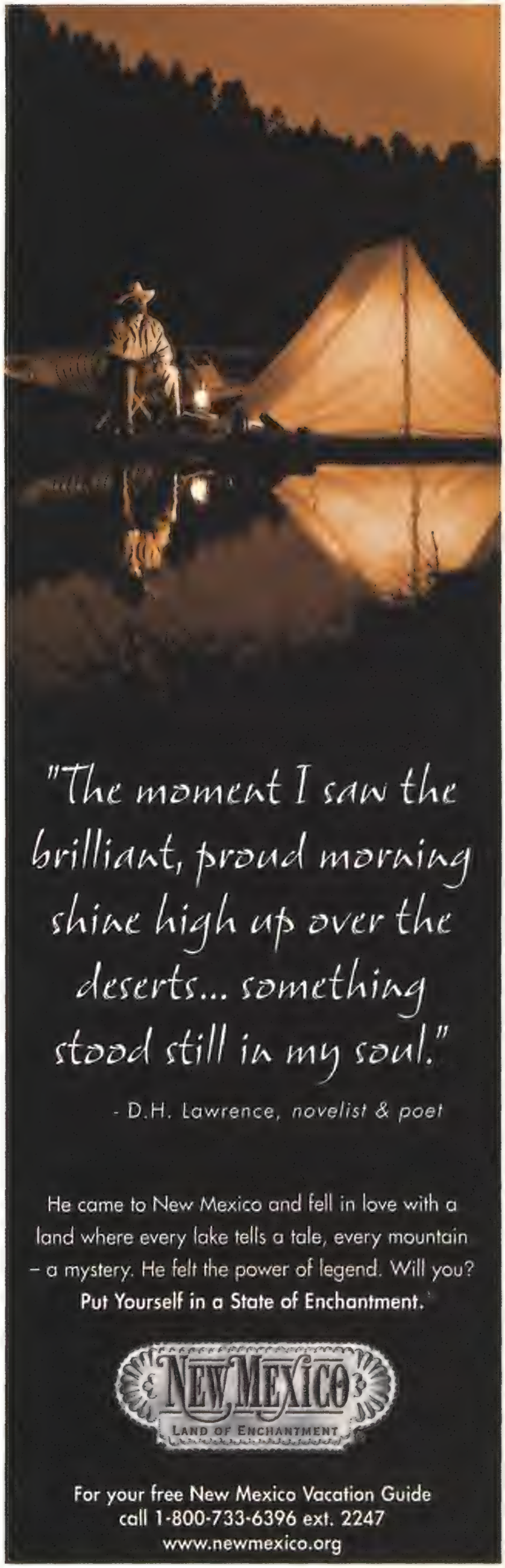
"In all likelihood," Stewart finished, "the dragon's bacteria has been battling with its immune system for millions of years, with both sides getting stronger and stronger over time to keep each other in balance."

"That's it!" Fredeking exclaimed. "Lead me to 'em!"

Nearly three years passed before Fredeking and two colleagues could secure permits to take samples of Komodo dragon saliva. Both the Indonesian and the U.S. governments had to be petitioned, because the dragon is an endangered species, and most of the 6,000 animals that remain are found within Komodo National Park, which covers several islands and is now a World Heritage Site. Finally, on November 30, 1995, came the momentous day. Fredeking and Jon Arnett, curator of reptiles at the Cincinnati Zoo, flew to Bali, where they met up with Dr. Putra Sastruwan, a biology professor and Komodo dragon specialist at the University of Udayiana in Bali. They took two days to recover from jet lag, then flew to the Indonesian island of Flores in a small Fokker plane that made Fredeking more nervous than the prospect of facing Komodo dragons.

The next day they crossed over to Komodo by ferry—another unnerving experience for Fredeking, since the ferry had sunk on several occasions. From a distance, the island appeared shrouded in fog, with protruding volcanic cliffs. Close-up, Fredeking saw that its coastline was lined with rocky headlands and sandy bays. Much of its interior was dry, rolling savanna, with bamboo forests halfway up the larger peaks. The island supported a variety of large mammals, all imported by man: deer, water buffalo, boar, macaque monkey and wild horse. No one knew how the Komodo dragons had come to the island. Paleontologists believed their genus evolved in Asia 25 million to 50 million years ago as reptiles, then migrated to Australia when those two land masses collided. Because Indonesia lay closer to Australia at that time, the dragons may have swum to the islands and proliferated, growing larger over time, because the islands contained no predators for them.

Hot and sweaty, the biologists spent their first night on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the island in a village that was nothing more than a cluster of bamboo huts. Over a local dinner of rice and fish, they heard stories of the dragons' ferocity. Eight villagers, mostly children, had been attacked and killed by Komodos in the 15 years since the national park was established and records began to be kept. One old man had paused beside a trail to take a nap: his supine form looked vulnerable and inviting, and he, too, fell victim to a dragon's steel-trap jaws. Other stories, unverifiable, had circulated ever since W. Douglas Burden came over in 1926 on behalf of the American Museum of Natural History and made a first formal study of the beasts, capturing 27 of them and naming them Komodo dragons. Burden also brought the first Komodo dragon back to New York City. He told the story of his adventure to Meriam C. Cooper, among many others, and fired the Hollywood producer's imagination. Cooper changed the dragon to an ape, added Fay Wray, and in 1933 gave the world *King Kong*.

It was the next morning that Fredeking saw a Komodo dragon rip open the belly of a terrified goat. He had briefly considered bringing tranquilizer guns to bag his prey, but scotched the idea when he learned that a sedated dragon is likely to be eaten by his peers. Komodos are so cannibalistic that they will eat each other, including their own young. Newly hatched dragons know, by biological imperative, to scamper immediately up tall trees and spend their first two years as arboreal creatures, safe from the snapping jaws of their parents below.

Instead of using sedatives, Fredeking and his cohorts emerged from their hiding places with long forked sticks and one long pole designed for catching crocodiles: an extendable pole with a wide noose at the end. The noose was slipped over the dragon's head and pulled tight. Before the befuddled crea-

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ture could react, six men jumped on him. The Cincinnati Zoo's Jon Arnett held the dragon's head and began wrapping duct tape around it. Others wrapped tape around its extended claws. Equally important, a ranger grabbed the dragon's powerful tail. Fredeking reached for the long Q-Tips he'd brought for swabbing at the dragon's saliva. He looked at the dragon's furious eyes and, then, startled at its third eye: a "parietal" eye in the roof of its cranium, which acts as a light-sensing organ. He dabbed at the saliva, shocked at how thick and viscous it was—like Vaseline. One sample was slipped into a vial, then another. Fredeking began to feel euphoric. That was when he heard one of the others say, in real terror, "Oh my God."

Fredeking looked up and felt the paralyzing fear of the hunter who has gone from being predator to prey. More than a dozen Komodo dragons were advancing from all sides. Drawn by the noisy struggle of the dragon that had been captured, the lizards had converged with the quaintly Komodian hope of eating it—along with the men around it. Panting with adrenaline, the men pushed at the dragons with their forked sticks. With their length, body mass and sheer reptilian power, the dragons easily could have pushed right up to the men and started chomping away, either at the duct-taped dragon or at the hors d'oeuvres plate of tasty human legs. But the sight of tall men with sticks seemed to confuse them. One of the park guards—an old hand at dealing with the dragons—aggressively advanced on one of the larger lizards, and pushed him away with his forked stick. For a tense minute or so, the outcome remained uncertain. Then, one by one, the dragons turned and clumped away. Fredeking took a long breath. "Man, oh man," he said. "What we do for science."

On that first trip, both of Fredeking's cohorts incurred deep scratches on the

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insides of their calves by sitting on the dragon's back to help restrain him. They knew that the dragon's scaly skin—as scaly as chain mail—was rife with bacteria too. Within hours, they were infected and running fevers. Fredeking was running a fever too. All three took Ciprofloxacin and soon felt better. Not surprisingly, the dragon's bacteria were susceptible, given that the bugs had probably never encountered commercial antibiotics.

Along with saliva swabs, Fredeking came away with samples of blood from the dragon's bleeding gums. Flash frozen in liquid nitrogen and stored in Thermos-like containers, the samples were flown back to Texas, where Fredeking's researchers got to work. They counted 62 different kinds of bacteria in Komodo saliva. The most potent of the lot was *Pasteurella multicida*, common in many domestic animals, though in far less virulent strains. They found antibiotic peptides, too, along with a small molecule that did an even better job of killing bacteria. In vitro, the molecule knocked out three of the worst bacterial pathogens: methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), and *E. coli* 0157:H7 or *Escherichia coli*. Don Gillespie, a veterinarian in touch with Fredeking because of his work with Komodos at the Nashville, Tennessee, zoo, worried that the peptides might not last long in the human body. But this new small molecule, he thought, might not be recognized by human antibodies, and so be a perfect candidate for a new class of antibiotic.

First, the researchers would have to try the peptides, and the molecules, in mice, then guinea pigs, then primates. And even the gung ho Fredeking knew better than to make any predictions. "If it makes mice grow long green tails and crave human flesh, we'll know it's not good," he said. "Basically, anywhere along the trail here, this thing could fall apart."

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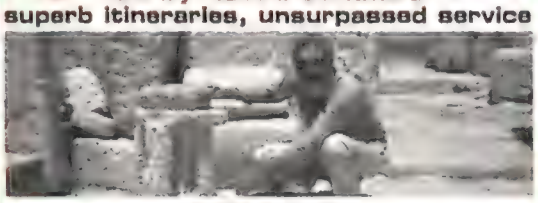

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HUNDREDS OF WOMEN FOUGHT IN THE CIVIL WAR DISGUISED AS MEN

BY ROBERT F. HOWE

AUGUST 30, 1862, PROVED TO BE yet another bloody day. Henry Clark was in the thick of things, fending off Federal troops in the Battle of Richmond, Kentucky, when the Confederate private caught an enemy shell in the thigh. Clark was swarmed by bluecoats and taken prisoner.

It was presumably when a Union medic treated Clark's wound that the soldier's tightly held secret was unmasked. Henry's real name was Mary Ann. Indeed, she was a divorced mother of two.

When Federal troops realized that they had a woman on their hands, they moved quickly to release her—as long as she swore to return to the life of a proper lady. They even gave her a dress to wear. She agreed and was freed, then quickly cast off the frock and made her way back to the rebel army, where she was promptly promoted. Not long after, a young Confederate soldier—having joined a crowd gathered around Clark, then apparently serving openly as a female officer—wrote home: "Pa among all the curiosities I have seen since I left home one I must mention, a female Lieutenant."

A curiosity, yes, but to the surprise of many Civil War buffs even today, Clark was by no means unique. She was one of an estimated 400 women who took up arms in the war; they were not nurses, or laundresses or cooks, but actual female soldiers disguised as men, who marched, mastered their weapons, entered into battle and even gave their lives.

Various histories have alluded to women's roles in combat during the War Between the States, but none have made so detailed and convincing a case as *They Fought Like Demons: Women Soldiers in the American Civil War*, to be published this month by the Louisiana State University Press. Coauthors Lauren Cook and DeAnne Blanton spent more than ten years combing through letters, archives and news reports to document some 250 women warriors.

"No one has accumulated this much data," says Cook, 46, who first tilled this turf in her 1994 *An Uncommon Soldier* (Oxford University Press), a compilation of letters from a female Civil War soldier. The authors' mission was

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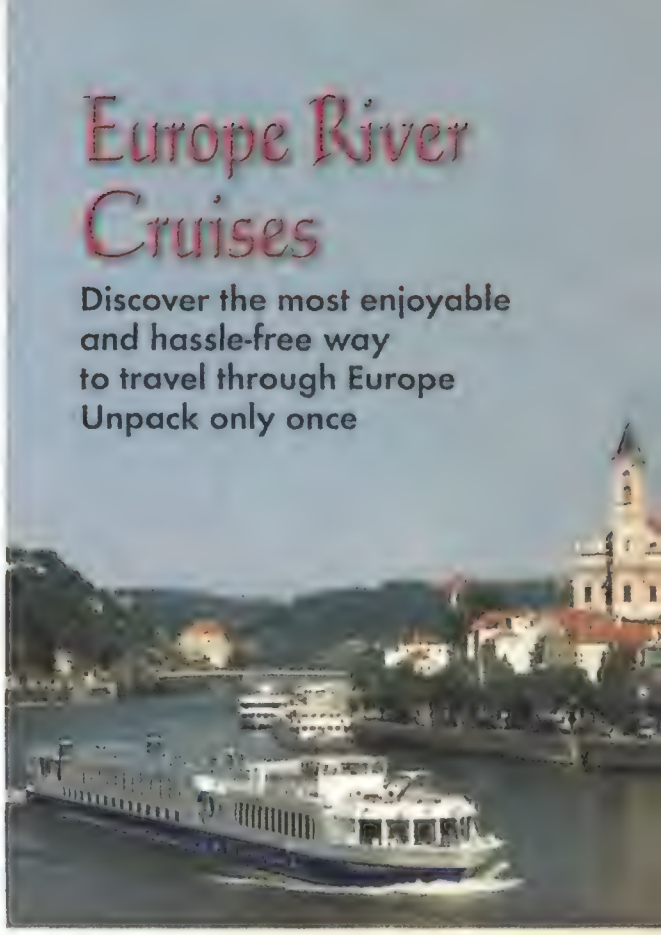

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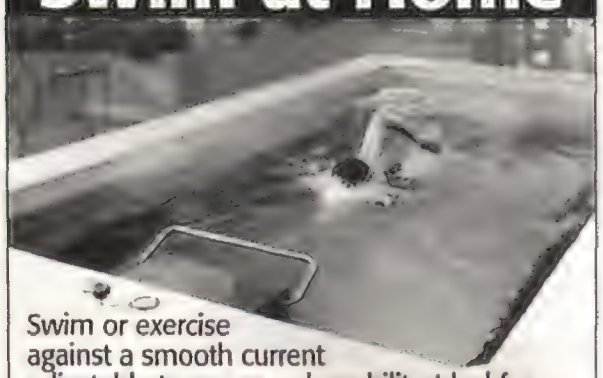

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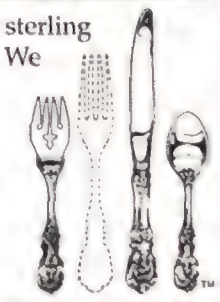

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"Those women had not been given their due, were misunderstood by military historians and the public."

not just to catalog the combatants. Their extensive research convinced them that the prevailing notions about women's participation in the war—that they had to be deranged or depraved—were way off the mark.

"We felt those women had not been given their due, that they were thoroughly misunderstood by military historians and the general public," says Cook, a special assistant to the chancellor for communications at Fayetteville State University-UNC in North Carolina. In fact, Cook contends, "they were just as successful as their male comrades, and what enabled them to be so successful was that no one knew that they were women."

Edwin C. Bearss, former chief historian for the National Park Service, is particularly impressed by the scope of the authors' work. "I'm sure some will take issue with their conclusions," he says, "but this is a very significant study. They were able to document a far greater number of women than I, and others, thought they would."

What would compel a woman to march into that terrible combat—and how could she conceal her identity in what must have been uncomfortably close quarters? Blanton and Cook offer a number of persuasive answers. In the case of Clark, for example, a bad marriage and the death of a brother-in-law at the hands of a pro-Union mob took such an emotional toll that she sought refuge in the military, according to a letter from her mother uncovered by the authors. But Martha Parks Lindley joined up just two days after her husband left for the 6th U.S. Cavalry. "I was frightened half to death," she told a newspaper. "But I was so anxious to be with my husband that I resolved to see the thing through if it killed me." It did not, and fellow troopers simply assumed that Lindley and the "young

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Says Cook: "Women have been vilified."

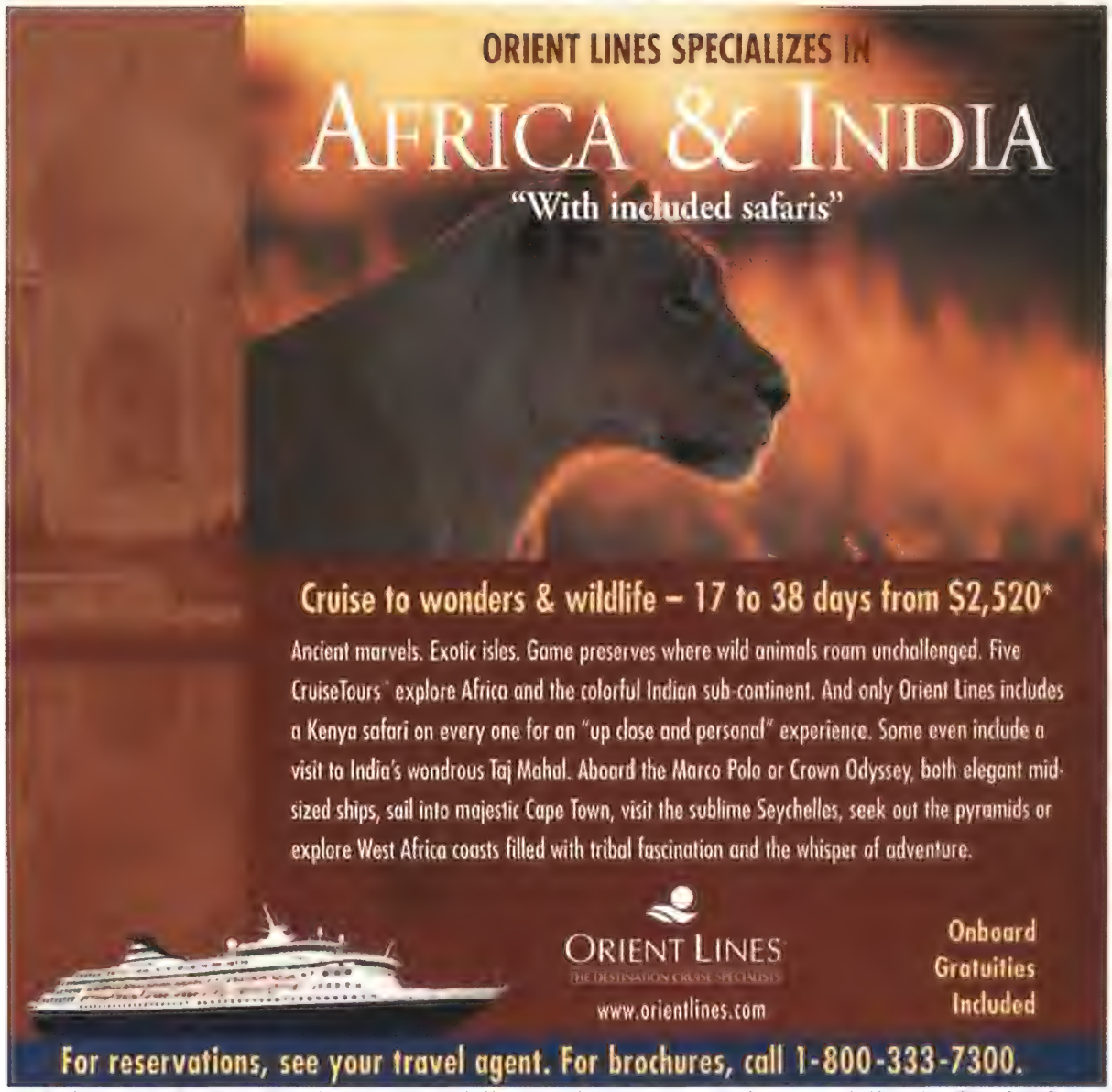
man" known as Jim Smith were just good friends. Then there was Charlotte Hope, who signed up in the 1st Virginia Cavalry to avenge the death of her fiancé, killed in a raid in 1861. Her goal: to slay 21 Yankees, one for each year of her beau's life.

Some joined to escape the misery of prostitution or destitution—a common problem with so few jobs open to women. Finance clearly figured into the decision of Sarah Rosetta Wakeman, alias Pvt. Lyons Wakeman, to sign up for the Union army. "I got 100 and 52$ in money," she wrote proudly. "I can get all the money I want."

Loreta Velazquez, a.k.a. Lt. Harry T. Buford, was one of several women who fought simply for the unadulterated thrill of it: "I plunged into adventure for the love of the thing," she said after writing a postwar memoir called *The Woman in Battle*. Many women felt the keen tug of patriotism. Union soldier Sarah Edmonds, an immigrant from Canada, expressed thanks that she was "permitted in this hour of my adopted country's need to express a tithe of the gratitude which I feel toward the people of the Northern States."

"What surprised me most was the realization that women soldiers enlisted largely for the very same reasons as the men did," says Blanton, 38. "Some were rebelling against the strict roles that society confined them in, but then there were women who went because

JESSE SHAW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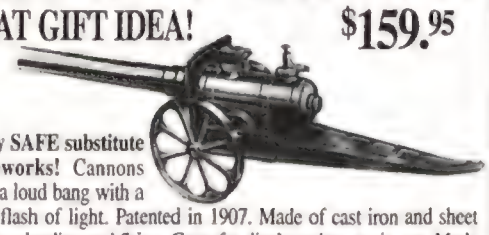

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Blanton hopes to hear from descendants.

the pay was good, or because everybody else in the family was signing up, or because they wanted to defend their country. Some just signed up to run away from home, just like so many boys did."

To get to the front lines, each woman had to pass herself off as a man. Many were detected immediately and given the boot. But physical exams of the time tended to be cursory, and both armies were often so desperate for recruits that virtually anyone could pass. Occasions for discovery were limited; troops routinely slept in uniform, baths were a novelty and latrines were so foul that many soldiers sought refuge in nearby woods. A high-pitched voice or a lack of facial hair could be attributed to youth. Several women attempted to blend in by learning to cuss like sailors, taking up gambling, or even dating local young ladies.

Some female combatants were given away by ladylike mannerisms and others were undone by boastings while inebriated. But as with Clark, most were unveiled only when doctors stripped away their clothes to examine a war wound.

A native of Grand Rapids, Michigan, Cook had virtually no interest in the Civil War until 1987, when she toured the battle site at Gettysburg, Pennsylvania. She was so moved by the experience that she joined a fife and drum corps and began participating in battle

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reenactments. Then, in 1989, during a re-creation of a military hospital at the Antietam National Battlefield in Sharpsburg, Maryland, she dressed as a male soldier "because I felt that was historically accurate." But when she visited the ladies' room, she caused a stir—not only among the women inside but with a ranger, who brusquely informed her that park rules did not allow women to participate in reenactments. "Their attitude was that the women of that era must have been oddballs, eccentrics and crazy, and didn't merit any kind of recognition or respect," says Cook. Her lawsuit against the Department of the Interior ultimately changed the rules.

The lawsuit also brought Cook to the attention of Blanton, a senior military archivist at the National Archives, whose own curiosity had been piqued in 1991 when she chanced upon a small file about women who fought in the Civil War. "I had read of [Cook's] difficulties with great interest and thought, 'You go, girl.'"

A decade after teaming up to work on *Demons*, Cook and Blanton are still fitting pieces of the puzzle. They cite the case, as it unfolded in letters written by soldiers, of a New Jersey woman who participated in the Union army's June 1862 siege of Richmond, Virginia, was wounded at the Battle of Antietam in September, and fought in the Union defeat at Fredericksburg in December. Just a few weeks later, on January 19, an astonished colonel in the Army of the Potomac wrote home: "A corporal was promoted to sergeant for gallant conduct at the battle of Fredericksburg—since which time the sergeant has become the mother of a child."

And there the story stops. "When she and her baby went home, was she celebrated or shunned?" Blanton asks. "I hope that a descendant will read our book and call up and say, 'Hey, that lady was my great-great-great-grandmother.'"

California freelancer Robert F. Howe reported on the Doolittle Raiders in August.

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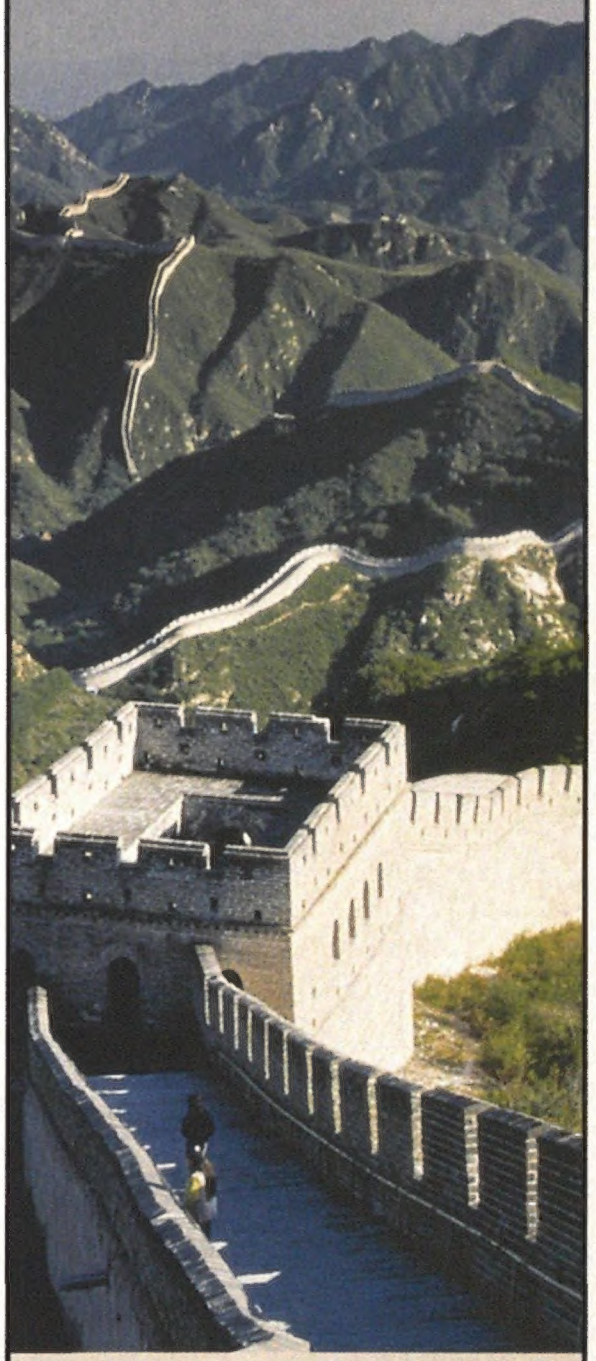

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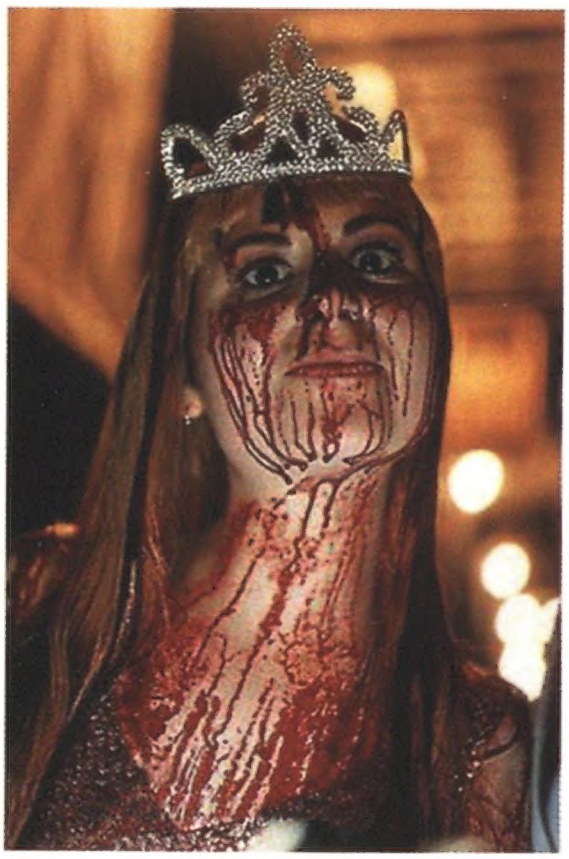
Blood and Gore

Al Gore (1994).

Boris Karloff at Emory University (1950).



"Carrie" (1999).

Dracula's castle, Romania (2001).

Westport, Connecticut (1960).

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